

FIELDIANA

Zoology

NEW SERIES, NO. 87

The Birds of Southeastern Madagascar

Steven M. Goodman^{1,2}

Mark Pidgeon²

A. F. A. Hawkins³

Thomas S. Schulenberg^{1,4}

¹Department of Zoology

*Field Museum of Natural History
Roosevelt Road at Lake Shore Drive
Chicago, Illinois 60605-2496 USA*

²World Wide Fund for Nature

*Aires Protégées, BP 738
Antananarivo (101), Madagascar*

³BP 8511

Antananarivo (101), Madagascar

⁴Conservation International

*2501 M Street, NW, Suite 200
Washington, D.C. 20037 USA*

Accepted August 20, 1996

Published November 26, 1997

Publication 1487

PUBLISHED BY FIELD MUSEUM OF NATURAL HISTORY

© 1997 Field Museum of Natural History

ISSN 0015-0754

PRINTED IN THE UNITED STATES OF AMERICA

Table of Contents

ABSTRACT	1
RÉSUMÉ	1
INTRODUCTION	2
THE SETTING AND STUDY SITES	3
The Setting of Southeastern Madagascar	3
Geology	3
Climate	5
Brief Review of Human Colonization and Occupation of the Region	6
Habitat Types of Southeastern Madagascar	7
Study Sites	16
METHODS AND TERMINOLOGY	19
Mist-netting	19
Census Surveys	20
Habitat Classification	20
Species Classification	20
Collections and Sight Observations	20
Condition of Reproductive Organs and Skull Ossification	21
Systematic Order and Nomenclature	22
Malagasy Bird Names	22
Malagasy Locality Names	22
Soft Part Colors	22
SPECIES ACCOUNTS	22
ANALYSIS AND DISCUSSION	90
General Overview of the Regional Avifauna	90
Relative Densities of Birds Based on Mist-netting	95
Elevational Distribution of Birds	100
Utilization of Sisal Plantations by Forest Birds	102
Faunistics and Biogeography	105
Conservation Problems in Southeastern Madagascar	111
ACKNOWLEDGMENTS	116
LITERATURE CITED	117
APPENDIX 1. GAZETTEER OF LOCALITIES MENTIONED IN THE TEXT	122
APPENDIX 2. NAMES OF PLANT GENERA, SPECIES, AND FAMILIES MENTIONED IN THE TEXT	125
INDEX TO MALAGASY VERNACULAR BIRD NAMES	127
INDEX TO SCIENTIFIC NAMES	128
3. View from summit of Pic Trafonaomby (1956 m), with bank of clouds rolling in	7
4. Littoral forest near Petriky, looking west	8
5. Strand forest at the border between the sea and littoral forest at Manafiafy	9
6. Lowland forest in the RNI d'Andohahela (parcel 1) at 400 m	10
7. Lowland gallery forest in the RNI d'Andohahela (parcel 1) at 400 m	11
8. Natural landslide in the RNI d'Andohahela (parcel 1) at 800 m	12
9. Sclerophyllous forest on exposed ridge in the RNI d'Andohahela (parcel 1) at 1700 m	13
10. Mossy forest in the RNI d'Andohahela (parcel 1) at 1850 m	14
11. Spiny forest in the RNI d'Andohahela (parcel 2)	15
12. View across Mandrare River toward gallery forest on the east bank	16
13. Secondary marsh habitat near Manafiafy	17
14. Pastureland converted from humid forest at the northern boundary of parcel 1 of the RNI d'Andohahela	18
15. Young sisal plantation near Amboasary-Sud	103
16. Total number of individuals per species recorded in sisal plantation along survey transects	104
17. Cluster analysis of faunal similarity of resident forest birds found at various sites on Madagascar	110
18. Remaining portion of the Analalava Forest	113
19. Charcoal pit in the Mandena Forest	115

List of Tables

1. Observations of <i>Milvus migrans</i> on morning transects in the Malaza Forest	29
2. Observations of <i>Coracopsis vasa</i> and <i>C. nigra</i> on morning transects in the Malaza Forest	44
3. Observations of <i>Agapornis cana</i> on morning and evening transects conducted in the Réserve Privée de Berenty	45

List of Illustrations

1. Map of southeastern Madagascar	4
2. Cross section across southeastern Madagascar	4

4. External measurements (in mm) of <i>Coua cristata maxima</i> and <i>Coua cristata pyropyga</i>	48
5. Number of <i>Phyllastrephus</i> spp. netted at humid forest sites	64
6. Bird species recorded at each of the study sites	92
7. Avifaunal composition of study sites in the RNI d'Andohahela	95
8. Distribution of birds along an elevational transect in the RNI d'Andohahela (parcel 1)	96
9. Summary of mist-netting results at study sites	98
10. Mist-netting summary in the littoral forests and spiny forest	99
11. Comparison of bird contact frequencies in the littoral forests of Manafiafy and Itapera based on dawn censuses	100
12. Mist-netting summary in the lowland humid forests	101
13. Mist-netting summary of birds captured along an elevational gradient in the RNI d'Andohahela (parcel 1)	102
14. Sisal use by birds adjacent to the Malaza and Bealoka forests	104
15. Distribution of resident forest birds at several well-known sites in humid forest and spiny forest	106
16. Faunal similarity indices using a biological species concept of resident forest-dwelling birds	109
17. Faunal similarity indices using a phylogenetic species concept of resident forest-dwelling birds	109
18. Comparison of bird-netting capture rate at relatively intact forested sites in the forests of Analalava and Marovony	114

The Birds of Southeastern Madagascar

Steven M. Goodman
A. F. A. Hawkins

Mark Pidgeon
Thomas S. Schulenberg

Abstract

Southeastern Madagascar, defined here as the region from Tolagnaro north to Manantenina and west to the Mandrare River and its upper tributaries, contains a remarkable variety of habitats, including humid forests, dry spiny bush, littoral forests, coastal zones, high mountains, and areas of inland freshwater habitat. Within this region and its variety of habitats 189 bird species have been recorded. This represents 68% of the birds known to occur on Madagascar, within a region representing approximately 10,000 km², or about 1.7% of the total land area of the island.

Information is presented on the distribution, general aspects of natural history, diet, breeding, weight, soft part colors, and local names of the region's avifauna. This information is based on our own field work, published and unpublished observations, and museum specimens.

The abrupt ecotone between wet and dry over a distance of a few kilometers is largely due to the north-south aligned Anosyenne Mountains, which act as a rain barrier or pluviometric fault. This shift in habitats over a short distance has few parallels elsewhere in the Old World tropics or subtropics and is reflected in extensive bird species turnover.

Virtually all natural habitats within the region are currently threatened as a result of human activities. Little remains of the once extensive lowland forests on lateritic soils as a result of clearing for swidden agriculture, and the spiny forest has been extensively exploited for charcoal production and cleared for sisal plantations. The major reserve within the area is the Réserve Naturelle Intégrale d'Andohahela, which is composed of three parts: parcel 1 is humid forest (63,100 ha), parcel 2 is spiny forest (12,420 ha), and parcel 3 is transitional forest (500 ha). The future is bleak for natural habitats that remain outside the current protected areas system.

Résumé

Le sud-est de Madagascar, défini ici comme la région comprise entre Tolagnaro au sud et Manantenina au nord et limitée à l'ouest par le fleuve Mandrare et ses affluents, abrite une remarquable variété d'habitats naturels, depuis la forêt pluviale sempervirente au bush épineux sub-aride, en passant par la forêt littorale, la zone cotière, les hautes montagnes et les eaux douces continentales.

Au sein de cette diversité de milieux naturels que présente cette région, 189 espèces d'oiseaux ont été répertoriées. Cela représente 68% du total des espèces d'oiseaux inventoriées à Madagascar. La région couvre approximativement 10,000 km², soit environ 1,7% de la surface totale de Madagascar. Des informations relatives à la distribution, à l'histoire naturelle, au régime alimentaire, à la reproduction, au poids, à la couleur des parties molles et aux noms vernaculaires malgaches de l'avifaune de cette région sont apportées. Les informations présentées sont issues de la synthèse de travaux de terrain originaux, de données scientifiques publiées, de données scientifiques non-publiées et de données muséologiques.

La netteté de l'écotone constaté sur seulement quelques kilomètres entre les habitats humides

at les habitats sub-arides est principalement le résultat de la présence de la chaîne Anosyenne qui, de par son orientation nord-sud, fait office de barrière de pluie. Ce brutal changement d'habitat sur une courte distance occasionne un renouvellement important des espèces d'oiseaux, phénomène constaté au sein d'autres sites tropicaux et sub-tropicaux de l'Ancien Monde.

Pratiquement tous les habitats naturels présents dans la région sont menacés de disparition de par les activités humaines. Il ne subsiste que de petites surfaces de forêt pluviale sempervirente de basse altitude sur sols latéritiques suite à la pratique de la culture itinérante sur brulis et le bush épineux sub-aride a vu sa superficie réduite par la production de charbon de bois et la culture du sisal. La principale aire protégée rencontrée au sein de cette région est la Réserve Naturelle Intégrale d'Andohahela composée de trois parcelles: la parcelle 1 est forêt pluviale sempervirente (63,100 ha), la parcelle 2 est bush épineux sub-aride (12,420 ha), et la parcelle 3 est forêt de transition (500 ha). L'avenir des habitats naturels localisés en dehors du système d'aires protégées est fortement hypothéqué.

Introduction

The natural ecosystems of Madagascar contain a remarkable diversity of habitats, including large but diminishing expanses of lush tropical forests, high mountain alpine zones, and almost surrealistic spiny bush. Reflected in this diversity of habitats is an avifauna that, although not as diverse as on other tropical islands (e.g., Borneo), shows a remarkably high level of endemism. Of the 204 extant resident bird species known from the island (Langrand, 1990; Langrand & Appert, 1995; Goodman et al., 1996), 106 breed only on Madagascar and 25 also occur on neighboring islands (Comoros, Mauritius, and Réunion). Thus, about half of the avifauna is strictly endemic to Madagascar, and almost two-thirds (64%) is restricted to the greater Malagasy region.

Much of the habitat diversity of Madagascar is compressed into the island's southeastern corner. Although much of this region is south of the Tropic of Capricorn, the humid forests are typically tropical in structure and species composition. The abrupt ecotone between wet and dry over a distance of a few kilometers is largely due to the north-south-aligned Anosyenne Mountains, which act as a rain barrier or pluviometric fault (Battistini, 1964) for weather systems moving in from the Indian Ocean. Diminishing precipitation associated with this rain shadow has a dramatic effect on the floristic structure and composition across this zone. This shift in habitats over a short distance has few parallels elsewhere in the Old World tropics and is reflected in extensive bird species turnover.

The southern limit of Madagascar's humid forests is reached on the windward side of the An-

osyenne Mountains. Here one may be surrounded by 30-m-tall trees with large buttressed roots, the soils are rich in organic material, and terrestrial leeches (an indication of high humidity) are a common occurrence. The local avifauna is composed typically of humid forest species. From a few exposed ridges, on the leeward side of the Anosyennes, one can see to the immediate west, within a few kilometers, dry forest with its characteristic baobab (*Adansonia*) trees and thick stands of spiny Didiereaceae. From such vantage points one can hear humid forest birds calling in the immediate vicinity while the sounds of the dry forest emanate from below. This abrupt and dramatic ecotone between wet and dry makes southeastern Madagascar so fascinating and different from other areas of the island.

No general synthesis on the birds of southeastern Madagascar exists. A. Grandidier visited the region, and various ornithological records were presented by Milne Edwards and Grandidier (1879). The Mission Zoologique Franco-Anglo-Américaine to Madagascar (1929–1931), which forms the basis for our modern working knowledge of the island's avifauna (Rand, 1936), did not visit this area. Over the past decade there has been an increase in ornithological activity on Madagascar, and numerous important records from the extreme southeast have been incorporated in the works by Langrand (1990) and Langrand and Sinclair (1994).

The purpose of this monograph is to summarize aspects of the natural history and distribution of bird species occurring in southeastern Madagascar. We discuss numerous aspects of bird ecology and focus on documenting the remarkable species turnover across the pluviometric fault.

The Setting and Study Sites

The Setting of Southeastern Madagascar

Within the limits of this study we define southeastern Madagascar as the region from Tolagnaro north to Manantenina and west to the Mandrare River and its upper tributaries (Fig. 1). All references refer to this area unless otherwise stated.

Geology

The geology of southeastern Madagascar is complex, and the "Fort-Dauphin" group is one of the most intense examples of metamorphism and uplifting on the island (Brenon, 1972; Bazot, 1974). The landscape of the region is dominated by two ranges, the Vohimena and Anosyenne mountains. The former starts just north of Tolagnaro. The eastern foot of the Vohimena chain runs north, parallel to the eastern sea coast but some 2–8 km inland, to just south of Manantenina. The eastern foothills of the Vohimena Mountains rise out of the coastal plain and form an abrupt transition from the sandy littoral zone to areas resting on lateritic soils. At several sites along this front the surface soil types change, typically with altitude, over a short ground distance. This shift in soils affects both the botanical and zoological communities.

The mountains are formed from Precambrian gneiss and granitic rocks, and their deposited alluvium is largely lateritic or ferrallitic soils (Bourgeat, 1972). The higher peaks of this range include Pic Vohamena (1358 m) and Pic Vohimena (1173 m). The eastern slopes of the range descend into numerous relatively small rivers that drain in a steep and short trajectory directly into the Indian Ocean. Along the eastern coast, at the base of the Vohimena Mountains, are a series of sediments dating from the Pleistocene, although these deposits are often mixed with sands of various ages. The main forests of Mandena and Manafiafy rest on Karimbolian and Flandrian dunes (Battistini, 1964).

The Anosyenne Mountains are to the west of the Vohimena Mountains and run more or less parallel along a southwest–northeast axis from just west of Ranopiso to the Isandra Valley at the base of the Midongy-Sud Massif (Battistini, 1964; Paulian et al., 1973). They have the same general geological history and composition as the Vohimena Mountains. The Anosyenne

Mountains are distinctly higher with numerous summits over 1800 m (e.g., Pic Trafonaomby [1956 m] and Pic Andohahela [1935 m]). The eastern slopes of the range form a precipitation barrier to weather systems moving over Madagascar from the open sea. These mountains provide the source for the Manampanihy and Efaho rivers. The former river drains towards the northeast and enters the sea at Manantenina, and the latter runs almost due south and meets the sea just west of Tolagnaro. Several small tributaries from the western slopes of the Vohimena Mountains also drain into the Manampanihy River. The western slopes of the Anosyenne Mountains form the source of the Mananara and Manambolo, which merge into the Mandrare River (Chaperon et al., 1993). This river, which enters the sea just south of Amboasary-Sud and 270 km from its start near Pic Trafonaomby, is the lifeblood of thousands of people living in the arid zone to the west of the Anosyennes. Soils to the immediate west of the Anosyenne Mountains are typically lateritic clays and abruptly shift at the Androy sedimentary region to siliceous sands. This region is geologically complex with the juxtaposition and infolding of numerous formations (Noizet, 1953).

The main upper spines of the Vohimena and Anosyenne mountains are separated by a distance of less than 15–25 km either side of the Ranomafana-Sud valley (Fig. 2). This valley is the conduit of the Manampanihy River, and the soils are largely metasediments formed by erosion of surrounding mountain systems. The only remaining forested connection between the two mountain ranges is north of Isaka-Ivondro and south of the Ranomafana-Sud valley and is composed of a series of ridges along a latitudinal axis consisting of the Col de Tsitongambarika, Col de Manangotry, and Col de Tanatana.

West of the Anosyenne Mountains is a large well-drained basin of diminishing rainfall, low-lying relief, and largely xerophilous vegetation. The basin covers an area of approximately 12,600 km² and is predominantly drained by the Mandrare River. The basin has rather distinct geological boundaries delineated by the Anosyenne Mountains to the east, the extensive Manambian cliff cuestas of tectonic origin to the north, and the shallower escarpment leading to the Ambovombe pan just west of the Mandrare River. This river valley is the lowest portion of the basin, often bordered in areas by alluvial floodplains. There is a gradual increase in altitude from the coast to the

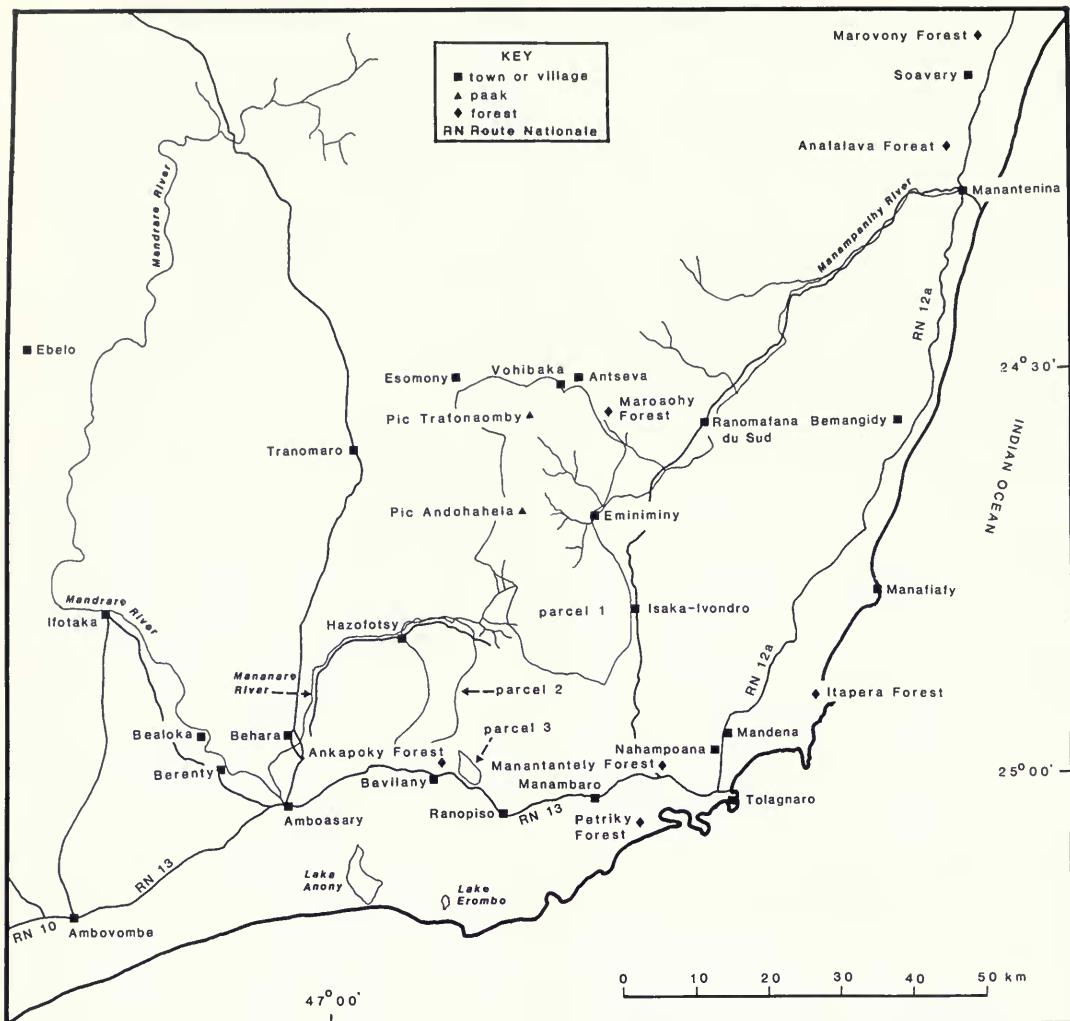


FIG. 1. Map of southeastern Madagascar. The reference to "parcel" designates the three parcels of the Réserve Naturelle Intégrale d'Andohahela.

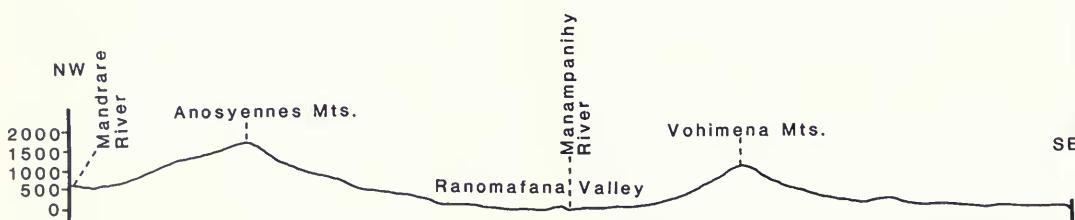


FIG. 2. Cross section across southeastern Madagascar along a trajectory running from north of Manafiafy northwest to the Mandrare River. (Adapted from Roche & Marchal, 1955-1956.)

Manambian Escarpment, 140 km to the north. Nevertheless, even at the base of these cliffs the altitude is slightly more than 300 m. The highest peaks in this region are the Vohimainty and Vohidagoro hills in parcel 2 of the Réserve Naturelle Intégrale (RNI) d'Andohahela, which rise to 1005 m. These hills are vestiges of the southern flank of the Anosyenne Mountains. In the north of the basin are the volcanic outcrops of the Vohidava ridge (922 m) and the Vohitsiombe mesa (904 m).

The major geological influences affecting the region's relief include the Precambrian crystalline basement characterized by the highly metamorphic Androyan system of volcanic intrusions mainly formed in the Upper Cretaceous and secondarily in the Late Tertiary and Quaternary. There is also a sedimentary shelf of Permian to Recent origin that dominates the coastal region and extends into the lower Mandrare basin (Battistini, 1972; Brenon, 1972). The relief in the northeast of the basin from Tsivory south to the confluence between the Mandrare and the Andratina rivers is dominated by the volcanic Androy Massif. Spectacular ledges, ridges, and mesas stand up from the crystalline beds of the Androyan system.

East of the basalt flows of the middle Mandrare basin is an area of extreme metamorphism with rich mineral deposits. This fractured and crystallized landscape is sometimes referred to as the Tranomaro group (Brenon, 1972), partly because the pediplains in the region of Tranomaro show typical consequences of the erosion of the Precambrian shelf (Battistini, 1972).

The lower Mandrare basin forms the eastern limit of the coastal sedimentary region. Much evidence is seen of recent sandstone and top sand deposition, particularly in the littoral zone and the lower continental shelf region of the western basin. There is a gradual replacement in the south of lateritic clays, not only because they are susceptible to accelerated erosion (Brenon, 1972; Jenkins, 1987), but also because they are overlain by more recent sedimentary deposition.

The dominant features of the Mandrare Valley are the considerable deposits of red sands. These generally take on two forms: (1) red soils overlying Cretaceous basalts and (2) red soils (colored by iron hydrates) that are essentially silicaceous sands (Jenkins, 1987).

The littoral zone around the mouth of the Mandrare River, extending a few kilometers to the east and extensively to the west, is an area of substantial Quaternary dune accumulation. The beach at

the ecotone between the sea and Lac Anony, for example, is a formation (still growing) of "living" white dunes referred to as the Flandrian regression (Battistini, 1972). To the west of Lac Anony are deposits of alluvial sands brought down the Mandrare River, to the east of the lake are deposits of the rubified dune system of the Tatsimian Period (early Quaternary), and to the north of the lake are deposits of red paleosols formed during a pluvial period of the Neogene (Besairie, 1970; Battistini, 1972). Besides the Tatsimian deposits, which extend inland as far as Ifotaka, the coastal formation is largely comprised of Karimbolian dunes of recent origin. These are the widespread dunes that extend around the southeastern coast north to Manafiafy.

The vegetation is determined by the interaction of climate and substrate. Thus, for example, the spiny forest is characterized by such species as *Alluaudia procera*, *A. ascendens*, and *Adansonia za* on red or rubified soils, whereas the more coastal and well-drained Quaternary and Recent sands are typified by increasingly xeromorphic plants such as *Euphorbia stenoclada*, *Alluaudia comosa*, and *Aloe vaotsanda*. Gallery forest along the Mandrare and Mananara rivers generally grows on alluvial sands deposited by these rivers.

Climate

RAINFALL—The most noticeable climatic feature of southeastern Madagascar is the rapid decrease in the amount of rainfall from east to west. To a much lesser extent there is a parallel decrease in precipitation on a north-south axis along the eastern coast. The moist easterly winds that hit the coast and Anosyenne Mountains provide orographic rainfall to the windward side of the mountains, whereas the leeward side to the west is in the rain shadow. Donque (1972, p. 136) summarized this transition zone: "the boundary between the semi-arid climate and the tropical damp climate of the south-east coast is extremely sharp, along a 'pluviometric fault', which runs along the line of the Anosy range: over the distance of some sixty kilometres as the crow flies, there is a transition from mean annual rainfalls of less than 600 mm to amounts in excess of 1500 mm." For example, at Tolagnaro the annual rainfall is about 1,500–1,800 mm; at Esira, 80 km to the northwest and west of the pluviometric fault, the annual rainfall is 740 mm; and at Behara, about 60 km west of Tolagnaro and in the heart of the south-

eastern spiny bush, the annual rainfall is 530 mm (Paulian et al., 1973; Donque, 1975). The pluviometric fault is much more abrupt than reflected above; the rate of meteorological change is obscured by the lack of weather stations in the transition zone. Further, no data are available from the summit zone of the Anosyennes, which is very humid, with perhaps as much as several meters of rainfall per year. The Réserve Privée (RP) de Berenty, 70 km west of Tolagnaro and 10 km southwest of Behara, received approximately 491 mm of rainfall in 1984 and 426 mm in 11 months of 1985 (Pidgeon, unpubl. data). RP de Berenty is the western limit of the area covered in this monograph. Perhaps the predictable aspect of the precipitation on the southern spiny bush is its unpredictability. Long periods of negligible amounts of rainfall causing sustained drought, followed by significant amounts of rain that provide much of the year's total in a period of a few days, are common.

Along the north-south trajectory near the coast at Nahampoana (7 km north of Tolagnaro) the annual rainfall is 2,130 mm, and at Manantenina (80 km north of Tolagnaro) it is 3,000 mm (Paulian et al., 1973). Along this axis, precipitation probably increases substantially inland and at higher altitudes. To a large extent the phytogeographical zones of the lowlands are directly correlated with rainfall pattern.

The crest of the Anosyenne Mountains, particularly along the eastern margins, is often shrouded in clouds (Fig. 3). This weather pattern is related to movements of humid air masses up from the east and the rapid descent of currents to the west into the hot and dry spiny bush (Humbert, 1935). These systems give rise to cooler temperatures, higher rainfall, and periods of thick fog in the summit areas. There also appear to be warmer air currents rising up the western slopes of these mountains. The cooler saturated air finds an effective barrier that it infrequently crosses, and when it does cross, precipitation is often evaporated off into the atmosphere (Ratsivalaka-Randriamanga, 1985).

Brief Review of Human Colonization and Occupation of the Region

The first evidence of humans in southeastern Madagascar dates from the 9th century (Rakotoarisoa, 1997; Wright & Rakotoarisoa, 1997); this is about 800 years later than the earliest

known human occupation of the island (MacPhee & Burney, 1991). Apparently, during the period from the 9th to the 12th century there were scattered small settlements along the coastal zone and along river valleys. Human subsistence relied primarily on fishing and cattle. There is no evidence that rice was grown during this period. The 13th and 14th centuries saw an increase in the size of villages and presumably a growth in the local population, as well as the presence of iron working. Further, Chinese celadon ceramics found at several sites document trade contact with the outside world.

The period from the 15th to the early 17th century witnessed great cultural change in the region, particularly in the emergence of hierarchical social organization (Wright et al., 1993). The archaeological record indicates that communities, for example in the Efaho River Valley, were fortified and there was a local influx of imported goods. This period is one of initial contact with Europeans, first the Portuguese, who established a fort in the region in 1540, then the French, and subsequently the Dutch (Decary, 1926). During this period there is evidence of irrigated rice, a practice that must have dramatically altered the freshwater wetlands of the region. Later in the 17th century, guns were imported, there was increasing social complexity, and subsistence agriculture was based on rice cultivation.

Etienne de Flacourt, a representative of the French *Compagnie des Indes Orientales* in the latter half of the 17th century who was based in Tolagnaro, was an excellent chronicler of cultural, social, and biological aspects of the region. Flacourt's treatise published in 1658 (reprinted edition 1995) recounted in detail the effects of the political perturbations during this period on the local people of the region. He also described elephant birds and another animal interpreted to be a giant extinct lemur, suggesting that these species still existed in the region at that time or that at least memory of them lingered in local oral traditions.

There is a rich modern oral cultural history from inland areas, including within and around the RNI d'Andohahela. A portion of this tradition probably dates from the 15th and 16th centuries (Charles, 1985; Razanabahiny, 1995). For example, the summit of Andohahela is reported to be the site where King Tehela sacrificed his son Mana, and even today this section of the reserve is considered taboo to enter. During our 1995 mission to the eastern slopes of the RNI



FIG. 3. View from summit of Pic Trafonaomby (1956 m) looking across the forested Anosyenne Mountains, with a bank of clouds rolling in from the east. Shrubs in the foreground are *Philippia*. (Photograph by N. Helme.)

d'Andohahela, in areas without any evidence of preexisting trails or signs of recent human utilization of the forest, we found tombs. The often collapsed stone pillars forming these monuments were covered with thick layers of moss, and in several cases large trees were growing in the center of the tombs. Pottery found slightly below the ground surface at about 800 m was dated on stylistic grounds to the 16th or 17th century (J. A. Rakotoarisoa, in litt.). On the basis of written accounts of voyagers who passed through the region, the 17th century probably marks the era of substantial human habitation of the regional forests (Rakotoarisoa, 1997). Thus, our notion of extensive untouched forest within the RNI d'Andohahela may be partly false. Rather, several hundred years of regeneration has been sufficient to hide the scars of previous human occupation.

The 18th and 19th centuries were a period of considerable political change associated in part with the Merina (1825) and French (1896) colonizations of the area. These external powers dismantled the social and political structures of the local Anosy culture and imposed strict rule. In the

20th century the ecological situation degenerated rapidly; regions described a few decades ago as forested are today no more than savannas. It has been estimated that 4,000 km² of the 7,000 km² of the region was still forested at the beginning of this century (Rakotoarisoa, 1994), and although no accurate estimates are available, the current forest cover is substantially less than this figure. The Anosy economy remains largely agrarian (Peyrot, 1980), and swidden agriculture (*tavy*) remains a mainstay in the region.

Habitat Types of Southeastern Madagascar

LITTORAL FOREST—Along the coastal margins of southeastern Madagascar, at less than 40 m above sea level, are a series of forests on sandy soils (Fig. 4) that comprise a distinct phytogeographic unit (Ratsivalaka-Randriamanga, 1987; Lowry & Faber-Langendoen, 1991). This forest type is characterized by more than 1,000 mm of precipitation per year, a canopy height of between 10 and 15 m, and a diameter at breast height (dbh)



FIG. 4. Littoral forest near Petriky, looking west. (Photograph by T. S. Schulenberg.)

of the largest emergent trees of generally less than 50 cm. These littoral forests, which were presumably one of the major lowland forest types before the region was colonized by people, are presently confined to a few remnant parcels, for example near Bemangidy, Manafiafy, Itapera, Mandena, and Petriky. The latter forest parcel, 10 km west of Tolagnaro, is in a region with distinctly less rainfall than found in littoral forests on the east coast and subsequently has a different floral community (Lowry & Faber-Langendoen, 1991).

A subcommunity of the littoral forest, known as strand forest, is the vegetational zone immediately adjacent to the coastal beach. This forest type, which is often no more than 600 m wide, tends to be composed of halophytic plants. *Pandanus* spp. and *Casuarina* are characteristic of this zone, particularly near Manafiafy, Itapera, and Mandena (Fig. 5). The general appearance of the littoral forest is of rather dense stands of short evergreen arborescents with stiff, rounded leaves, many of which are covered with a waxy cuticle. Wind desiccation and well-drained sandy soils may produce seasonal water stress.

HUMID FOREST—The classification of this forest

type is defined in various ways by botanists, and numerous alternative names are used. Humid forests, as defined here, are exclusively on lateritic soils in areas that receive at least 1,000 mm of rainfall per year, with a canopy height exceeding 20 m tall, and with the largest canopy trees reaching 100 cm dbh. White (1983) divided this forest type into "rain forest" and "moist forest"; the former receives over 2,000 mm of rain per year and has a larger overall stature than the latter, which receives between 1,000 and 2,000 mm of rain per year.

Humid forests can also be segregated into different types based on elevation. The upper elevational limit of lowland humid forest generally occurs between 800 and 1000 m; several of our study sites (e.g., Marovony, Analalava, and Manantantely) fall within this forest type. Forests above 600–800 m elevation are classified here as montane humid forest. With increasing elevation the stature of the forest decreases and the densities of bamboos, epiphytes, mosses, and tree ferns increase. The upper portions of montane humid forest are often referred to as moss forest or upper montane humid forest.



FIG. 5. Strand forest at the border between the sea and littoral forest at Manafiafy. The dominant tree is *Pandanus*. (Photograph by S. M. Goodman.)

The following description of the plant communities and forest structure along an elevational transect conducted in parcel 1 of the RNI d'Andohahela in late 1995 is based on that of Helme and Rakotomalaza (in prep.). The forest at 400 m had a canopy height of 15–25 m, and the dominant trees were *Sorindeia madagascariensis*, *Ilex mitis*, *Syzygium*, *Oncostemon*, *Tambourissa* spp., *Dracaena reflexa*, and various Rubiaceae (Fig. 6). Emergent trees, many of which had large buttressed bases, reached 25–35 m, and the common species included *Dilobeia thouarsii*, *Chrysophyllum boivinianum*, *Sloanea rhodantha*, and *Ocotea*. Epiphytes were present, covering less than 20% of the available surface, and consisted of *Asplenium*, *Pothos scandens*, and various mosses. There was a high density of lianas. Large palms and bamboo clumps were not particularly common. Along riverbanks was a riparian plant community composed of *Aphloia theiformes*, *Ficus*, *Antiroheia*, *Weinmannia* spp., *Phyllanthus* spp., and *Dombeya* spp. *Ravenala madagascariensis* was more common in light gaps along the river than in undisturbed forest (Fig. 7).

At about 800 m there was a distinct floristic and structural change in the forest, most pronouncedly marked by an increase in the density and diversity of epiphytic plants. Canopy trees had at least 20–50% epiphytic cover, with *Usnea* lichens, *Asplenium* ferns, and *Bulbophyllum* orchids dominating. Mosses were common. There also was a drop in the canopy height to between 12 and 20 m and in the emergent trees to 20–25 m. Canopy plants were dominated by *Macaranga*, *Oncostemon*, and the families Moraceae, Myrtaceae, Clusiaceae, and Monimiaceae. Emergents included *Sloanea rhodantha*, *Canarium obovatum*, *Dilobeia thouarsii*, *Ocotea* spp., and various Myrtaceae and Moraceae. The understory was dominated by Acanthaceae rather than *Tambourissa*, as at 400 m. At 800 m, bamboo, particularly the lianescent *Nastus*, was common and formed dense tangles in light gaps. Large palms were rare, although small understory species were common. In the area near our 800 m camp there was a high degree of community heterogeneity, suggesting strong environmental or edaphic gradients. Further, there were clear signs of natural



FIG. 6. Lowland forest in the Réserve Naturelle Intégrale d'Andohahela (parcel 1) at 400 m. Note the large buttressed *Sloanea* and relatively light epiphytic growth on tree trunks and branches. (Photograph by M. Pidgeon.)

landslides, the slopes of which had a different pioneering plant community than gallery or closed forest habitats (Fig. 8).

Another major structural change occurred at about 1000 m, marking the shift from lowland to montane forest, which included a substantial in-

crease in tree density, heavy epiphytic loads (50–80% cover), ground carpeted with spongy mosses, some areas of dense bamboo, and the near absence of emergent trees. Canopy height varied from 12 to 20 m, and trees included *Sloanea rho-dantha* (with distinctly smaller root buttresses



FIG. 7. Lowland gallery forest in the Réserve Naturelle Intégrale d'Andohahela (parcel 1) at 400 m. (Photograph by M. Pidgeon.)

than at lower elevations), *Canarium*, *Chrysophyllum boivinianum*, and *Croton monge*. Lianas were still found in some areas but generally were less common than at lower elevations. The understory was relatively open and consisted of Acanthaceae, young saplings of canopy trees, *Oncostemon* spp., and in moister areas *Cyathea* spp. and *Marattia fraxinea*.

At 1600 m the valleys contained moist montane forest and the ridges carried sclerophyllous forest (Fig. 9). Valley bottoms were dominated by *Sloanea rhodantha*, often attaining a height of 30 m, and *Strongylodon* lianas; at the base of ridges *Ravensara* and *Tambourissa* were common; and on ridges in the sclerophyllous forest *Dicoryphe viticoides*, *Tina isoneura*, *Elaeocarpus*, *Gaertnera*, and *Aguaria* were found. Moist areas were dominated by dense populations of *Impatiens*. Epiphytes were abundant, with 80–100% coverage on horizontal branches. There were large clearings in the forest (0.5 ha), presumably caused by cyclone damage and landslides, and these areas were colonized by the pioneering tree species *Macaranga* and *Dombeya*.

At 1900 m, on a plateau just below the summit of Trafonaomby, the forest was largely sclerophyllous in nature with a high density of stems and low diversity, dominated by the families Araliaceae, Lauraceae, Apocynaceae, and Flacourtiaceae (Fig. 10). The understory was basically a monoculture of low-growing Acanthaceae with widely scattered patches of sedges. Epiphytic loads were heavy, approaching 100%. Lianas were rare, and palms were absent. The summit zone was covered with 3-m-tall sclerophyllous forest composed of *Philippia* spp., *Alberta*, *Pittosporum*, *Aguaria*, and *Vaccinium*.

TRANSITIONAL FOREST—In the low foothills just west of the Anosyenne Mountains is a distinct vegetational structure referred to as transitional forest (O'Connor et al., 1985; Ratsivalaka-Randriamanga, 1987). One of the last remnants of this forest type is found in parcel 3 of the RNI d'Andohahela, the southern boundary of which borders Route Nationale 13 between Amboasary-Sud and Tolagnaro. In phytological characteristics this forest type is intermediate between humid and spiny forests. Mean annual precipitation in parcel

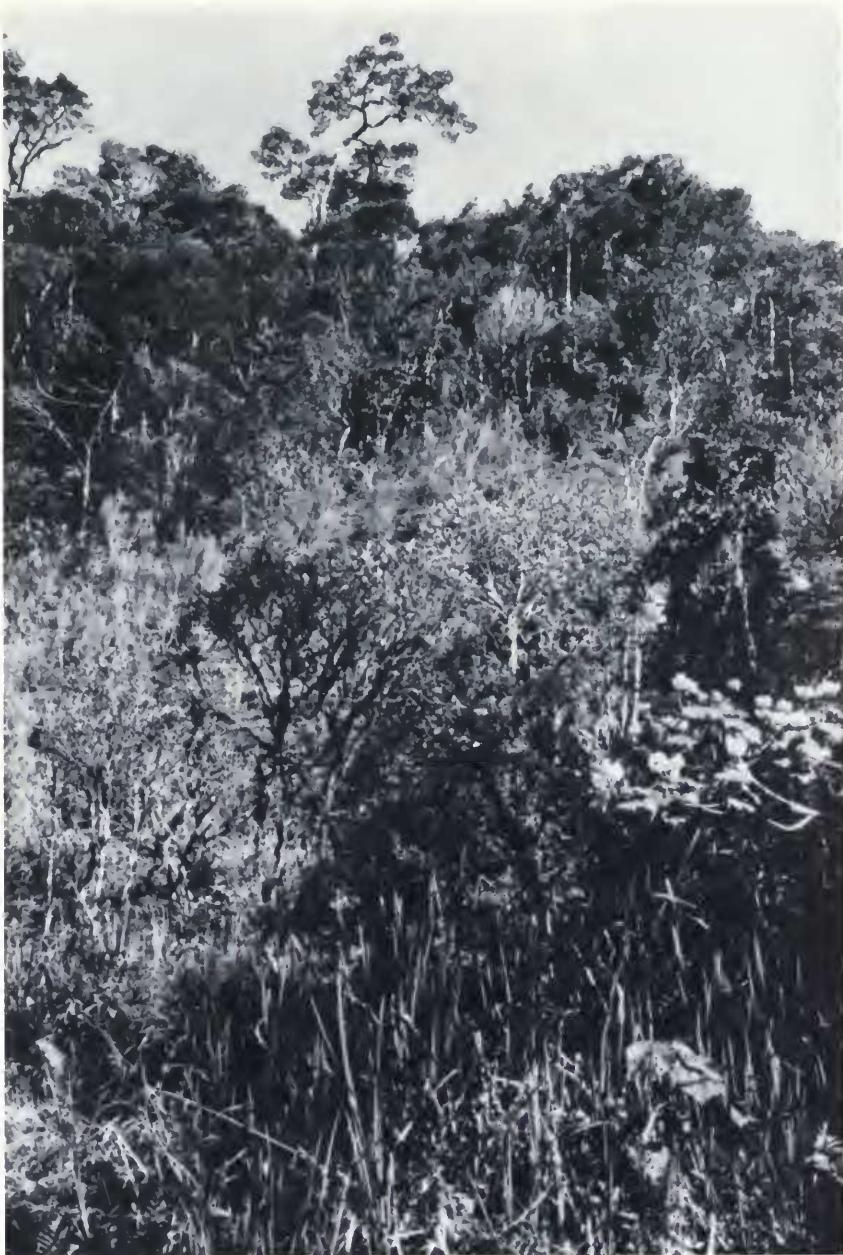


FIG. 8. Natural landslide in the Réserve Naturelle Intégrale d'Andohahela (parcel 1) at 800 m along the Andranohela River. Disturbed areas are colonized by *Typha*, *Dombeya*, *Weinmannia*, and *Philippia*. (Photograph by N. Helme.)

3 is 700–800 mm per year (Nicoll & Langrand, 1989), and the elevation varies between 100 and 350 m (Eboroke, 1994).

The vegetation of parcel 3 varies with edaphic, meteorological, and topographic conditions. In valley bottoms there is a multilayered forest with

a 10- to 12-m-high canopy and relatively dense understory. The dominant plants are *Millettia*, *Maba myriophylla*, *Commelina ramulosa*, *Erythroxylum gerrardi*, *Cerbera venenifera*, *Dypsis decaryi*, and *Croton* spp. (Eboroke, 1994; Dransfield & Beentje, 1995). On slopes canopy height



FIG. 9. Sclerophyllous forest on exposed ridge in the Réserve Naturelle Intégrale d'Andohahela (parcel 1) at 1700 m. (Photograph by N. Helme.)

is about 10 m and the understory is dense, and the most common plants are *Croton*, *Commelina ramulosa*, *Tarenna purinosum*, *Flacourtie lucidaefolia*, *Diospyros myriophylla*, *Vepris sclerophylla*, and *Alluaudia humbertii* (Eboreke, 1994). The transitional forest of parcel 3 is probably the only reserve on Madagascar to have been designated primarily for the protection of a single plant species, *Dypsis decaryi*, which is its most visible and distinctive aspect (Ratsirarson et al., 1996).

SPINY FOREST (= SUBARID THORN SCRUB) AND GALLERY FOREST (= RIVERINE AND RIPARIAN FOREST)—To the west of the Anosyenne Mountains and the transitional forest is a distinct forest type characterized by low precipitation (less than 700 mm per year) and a fairly dense structure (Lowry & Faber-Langendoen, 1991). Along the Route Nationale 13 this forest type commences just west of the Col de Ranopiso, and slightly further west at Bevilany the flora is distinctly xerophytic (Decary, 1927). Soils are usually lateritic, but at a few sites they are sandy. Our study site at Ankapoky is characteristic of this forest type, as is parcel 2 of the RNI d'Andohahela (Fig. 11). The vegeta-

tion of southeastern spiny forest is typically dominated by *Alluaudia*, *Decaryia*, *Croton*, *Euphorbia*, *Adansonia*, *Sarcostemma*, *Cynanchum*, *Kalanchoe*, *Pachypodium*, *Aloe*, *Delonix*, *Chadsia*, *Albizia*, *Crotalaria*, *Acacia*, *Commiphora*, and, particularly on the rocky outcrops, *Xerophyta*. This is truly a deciduous forest. Leaf fall is extensive in the spiny forest by the beginning of September, giving the appearance of an almost dead, petrified forest. Under conditions of severe water deprivation, some species will even drop branch segments.

The spiny forest, often growing on higher and rockier ground with no permanent water table, relies on several adaptations to take advantage of a fleeting wet season with temporary groundwater. The ability of spiny forest plants to store water in tissues is key to their survival. Certain species have swollen trunks and thin leaves (e.g., *Adansonia*, *Moringa*, *Pachypodium*), or they have woody trunks and succulent leaves (e.g., *Aloe*, *Kalanchoe*). Some woody plants have extensive penetrating root systems and/or subterranean water storage vessels, and some succulent plants are



FIG. 10. Mossy forest in the Réserve Naturelle Intégrale d'Andohahela (parcel 1) at 1850 m and on plateau directly below Pic Trafonaomby. This largely sclerophyllous forest had a high density of stems and low plant species diversity, dominated by the families Araliaceae, Lauraceae, Apocynaceae, and Flacourtiaceae. The understory was dominated by low-growing Acanthaceae with occasional patches of sedges. (Photograph by N. Helme.)

caulescent photosynthesizers with green stems (e.g., arborescent *Euphorbia*). Exceptionally, some plants (e.g., *Alluaudia*) exhibit succulent stems together with spines and succulent caducous leaves.

Throughout the spiny bush there are permanent and ephemeral river valleys, along the margins of which grows gallery forest. The gallery forest largely is a woody forest that provides significant shade from canopy trees and taps a fluctuating water table. In contrast to the spiny forest, the gallery forest retains a semi-evergreen appearance all year. Important shade trees rarely drop all of their leaves, thus providing protection for some more susceptible understory plants. Some tree species also have the ability to fold their leaves (e.g., *Tamarindus*, *Acacia*, *Bauhinia*) during drought to minimize evapotranspiration. Gallery forest is dominated by a relatively narrow band of vegetation composed principally of *Tamarindus indica*, *Acacia rovumae*, *Neotina isoneura*, *Celtis philippensis*,

and *Rinoria greveana*. The Malaza Forest bordering the Mandrare River, at RP de Berenty, is typical of this forest type. Other dominant woody plants include *Celtis gomphophyla*, *Albizia polyphylla*, *Crateva excelsa*, *Tabernaemontana*, *Ficus*, and *Bauhinia*. The transition between gallery forest and adjacent spiny forest is usually abrupt (Fig. 12), although within the transition zone some species are shared.

FRESHWATER—The lower slopes of the Anosyenne and Vohimena mountains and the eastern coastal plain contain freshwater lakes, streams, rivers, and marsh systems. The vegetation of these aquatic systems varies considerably depending on soil type, water movement and depth, etc., but common elements include various grasses (Poaceae), sedges (Cyperaceae), water lilies (*Nymphaea*), pitcher plants (*Nepenthes madagascariensis*), *Pandanus* spp., *Ravenala madagascariensis*, and *Typhonodorum* (Lowry & Faber-Langendoen, 1991; pers. obs.)



FIG. 11. Spiny forest in parcel 2 of the Réserve Naturelle Intégrale d'Andohahela. The dominant tree in the photo is *Alluaudia ascendens* (Didiereaceae). (Photograph by T. S. Schulenberg.)

(Fig. 13). A considerable portion of freshwater habitat has been converted to rice paddy.

MARINE—The coastal beaches and lagoons provide a wide range of habitats. Seabirds are regularly observed along coastal areas, particularly during and immediately after storms. Coastal sandy beaches and tidal estuaries provide habitat

for resident and migrant shorebirds. Mangroves are found in a few areas, particularly along coastal lagoons and inland brackish rivers (Lowry & Faber-Langendoen, 1991).

ANTHROPOGENIC—By far the greatest portion of the land area of southeastern Madagascar represents not one of the natural habitats de-



FIG. 12. View across Mandrare River, looking east. On opposite bank is a narrow band of gallery forest. In the distance are the hills in parcel 2 of the Réserve Naturelle Intégrale d'Andohahela. (Photograph by M. Pidgeon.)

scribed above but rather some form of human-modified habitat, including grasslands, often used for cattle rangeland, formed by the cutting of forests and maintained by regular burning to prevent regeneration (Fig. 14); various types of secondary forest; exotic tree plantations, mostly *Eucalyptus*; and agricultural lands and garden plots ranging from extensive rice paddy areas to planted fields. Areas of forest cleared for swidden agriculture are referred to as *tavy*. A wide variety of crops are grown in the region.

Study Sites

FIELD WORK CONDUCTED BY M. PIDGEON (MP)—Between October 1983 and November 1985 field studies were largely restricted to the gallery forests of Malaza and Bealoka with side trips to Bevala, Anjapolo, Ifotaka, and Lac Anony. In October 1984 a brief survey commissioned by the World Wide Fund for Nature (WWF-US) was undertaken in the Bevilany and Fotsivolo Hills between Route Nationale 13 and

the southern border of parcel 2 of the RNI d'Andohahela. During this period, some time was spent in the Andraraky Hills due east of Mokobe village.

In 1984 a visit was made to parcel 2 of the RNI d'Andohahela in the area bordering Hazofotsy, and the following year this parcel was circumnavigated on motorbike via Mokobe, Ankilitelo, and Ambatoabo. That same year the region along the Tanatana Trail (Isaka-Ivondro to Andonabe) and the Isedro Trail (Eminiminy to Mahamavo via Col d'Ambatomanaha) was visited. Between March 1988 and September 1990 parcel 1 of the RNI d'Andohahela was explored more fully. Several exploratory trips were conducted, including the Tanatana Trail, the Isedro Trail to Evasia and Imonty, the northern boundary trail between Enakara and Vohibaka, and the route from Esomony to Vohibaka (via Trafonaomby) and Marotsiva.

In 1989 parcel 3 of the RNI d'Andohahela was circumnavigated and explored, with mammal trapping and mist-netting done in January 1990. In July and August 1989 a 3-day hike was undertaken to traverse parcel 2 of the RNI d'Andohahela from Ha-

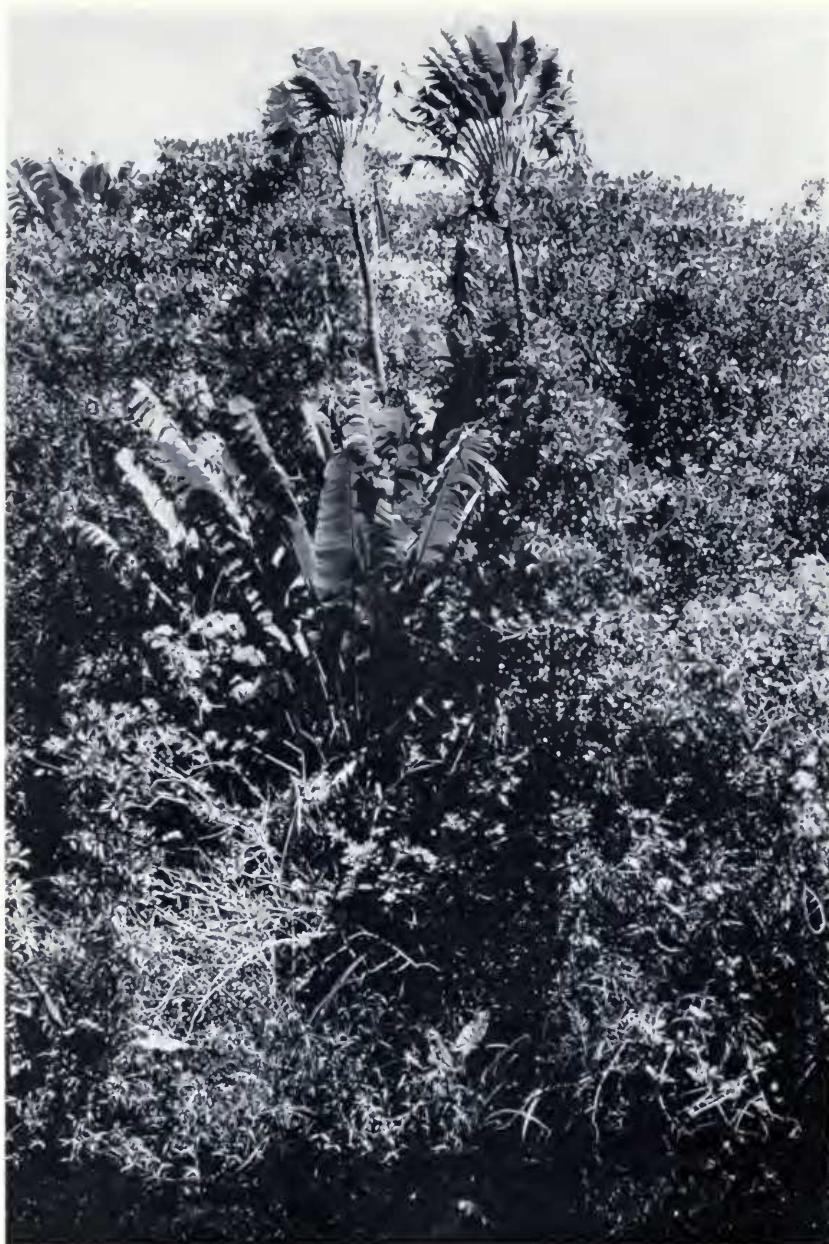


FIG. 13. Secondary marsh habitat near Manafiafy. *Ravenala madagascariensis* (Strelitziaceae) is the banana-like tree in the center of the photograph. (Photograph by S. M. Goodman.)

zofotsy to Ranomainty. This route passed via the summits of Vohidagaro and Vohimainty. In April 1990, Tsivory (120 km north of Ambovombe) was visited to spot survey the forêt classée, which incorporates the Vohidava Hills. MP returned on the

western side of the Mandrare River via Ebelo and then went on to Ifotaka.

FIELD WORK CONDUCTED BY S. M. GOODMAN (SMG) AND T. S. SCHULENBERG (TSS) IN 1989 AND 1990—Between September 1989 and early January



FIG. 14. Pastureland converted from humid forest at the northern boundary of parcel 1 of the Réserve Naturelle Intégrale d'Andohahela near Vohibaka. (Photograph by M. Pidgeon.)

1990 (SMG and TSS) and between September and November 1990 (SMG), a zoological research group assessed the potential environmental effects of proposed mining of coastal mineral deposits in southeastern Madagascar by QIT-Fer et Titane, Inc. (QIT). The primary role was to determine the species of birds occurring in this region; other members of the group conducted surveys of reptiles, amphibians, small mammals, and lemurs. In addition, other research teams performed similar surveys of the botany of the region. As a result of these studies, southeastern Madagascar is biologically one of the best-known regions on the island.

Study techniques are described below. The itinerary at the main study sites, all in the Province de Toliara, Fivondronana de Tolagnaro, follows.

Mandena Forest (littoral)—8 km NE Tolagnaro, 24°58'S, 47°01'E, 20 m; 6–20 September 1989—TSS.

Petriky Forest (littoral)—6.5 km SE Manambaro, 25°04'S, 46°53'E, 20 m; 22 September–2 October 1989—TSS.

Manafiafy Forest (littoral)—1.5 km NW

Manafiafy (St. Luce), 24°47'S, 47°12'E, 20 m; 5–20 October 1989—SMG and TSS.

Manafiafy Forest (strand forest)—2.5 km SW Manafiafy (St. Luce), 24°48'S, 47°11'E, 40 m; 21–25 October 1989—SMG and TSS; 18–22 December 1989—SMG.

Analalava Forest (humid)—7 km N Manantenina, Forêt d'Analalava, 24°13'S, 47°19'E, 40 m; 28 and 29 October 1989 (reconnaissance)—SMG and TSS; 5–11 November 1989—SMG and TSS; 23–25 November 1990—SMG.

Marosohy Forest (humid)—31 October and 1 November 1989 (reconnaissance)—SMG and TSS. Forêt de Marosohy, along tributary of Tsitongatona River, along Enakara–Antseva forest trail, 15.5 km (by air) WNW Ranomafana-Sud, 24°34'S, 46°48'E, 725 m; 23 November to 4 December 1989—SMG. Forêt de Marosohy, along tributary of Tsitongatona River, along Enakara–Antseva forest trail, 15 km (by air) WNW Ranomafana-Sud, 24°34'S, 46°49'E, 425 m; 4–14 December 1989—SMG.

Bezavona Forest (humid)—1.5 km (by air)

NW Nahampoana, 7.5 km (by air) NNW Tolagnaro, Forêt de Bezavona, 24°58'S, 46°58'E, 75 m; 24 December 1989 (reconnaissance); 26–30 December 1989; 17, 23, 25 September, 13 and 21 October 1990 (day trips from Tolagnaro)—SMG.

Manantantely Forest (humid)—12.2 km (by air) NE Manambaro, 8.5 km (by air) NW Tolagnaro, Forêt de Cascade, 24°59'S, 46°56'E, 100 m; 15 September 1990 (reconnaissance)—SMG; 27 September to 3 October 1990—SMG.

Ankapoky Forest (spiny)—13 km (by air) NE Amboasary-Sud, 21 km (by air) NW Ranopiso, Forêt d'Ankapoky, 24°59'S, 46°31'E, 70–120 m; 8–13 October 1990—SMG.

Itapera Forest (littoral)—19.5 km (by air) NE Tolagnaro, Forêt d'Itapera, 24°52'S, 47°07'E, 0–20 m; 15 September 1990 (reconnaissance)—SMG; 15–20 October 1990—SMG.

Marovony Forest (humid)—19 km (by air) NNE Manantenina, Forêt de Marovony, 24°06'S, 47°22'E, 50 m; 27 October to 4 November 1990—SMG.

ACCOUNT OF FIELD WORK CONDUCTED BY SMG, F. HAWKINS (FH), AND MP IN LATE 1995—From 19 October to 14 December 1995 a multidisciplinary and multinational group of biologists conducted an inventory of the RNI d'Andohahela. The main focus of the project was to survey an elevational transect of the humid forest zone of parcel 1. Five sites, centered on camps at 440, 810, 1200, 1500, and 1875 m, were the focal points of this mission. Further, a sixth site was surveyed in the spiny forest habitat of parcel 2.

During this survey FH was the principal ornithologist, and he conducted point counts (see *Census Surveys*, p. 20) and made general observations. SMG and MP worked primarily with mammals and invertebrates but also had time for ornithological observations, which were reported to FH. Mamy Ravokatra was responsible for the bird netting, and the captured birds were processed by SMG. In general we tried to use several different techniques to maximize data gathered and to approach near completeness of the transect bird lists (Bierregaard, 1990; Remsen, 1994).

Camp sites, all within the Province de Toliara, and inclusive dates of occupancy follow.

Camp 1—19–28 October 1995. RNI d'Andohahela, parcel 1, 8 km NW Eminiminy, 24°37.6'S, 46°45.9'E, 440 m.

Camp 2—28 October to 7 November 1995. RNI d'Andohahela, parcel 1, 12.5 km NW Eminiminy, 24°35.6'S, 46°44.3'E, 810 m.

Camp 3—7–17 November 1995. RNI

d'Andohahela, parcel 1, 13.5 km NW Eminiminy, 24°35.0'S, 46°44.1'E, 1200 m.

Camp 4—17–27 November 1995. RNI d'Andohahela, parcel 1, 15.0 km NW Eminiminy, 24°34.2'S, 46°43.9'E, 1500 m.

Camp 5—27 November to 5 December 1995. RNI d'Andohahela, parcel 1, 20.0 km SE Andranondambo, 24°33.7'S, 46°43.3'E, 1875 m.

Camp 6—7–15 December 1995. RNI d'Andohahela, parcel 2, 7.5 km ENE Hazofotsy, 24°49.0'S, 46°36.6'E, 120 m.

Methods and Terminology

Mist-netting

At each site a series of 12-m mist nets was erected. The bottom edge of each net was within 20 cm of the ground. The nets were monitored at regular intervals between sunrise and 1 hour after sunset. Nets were left open for 24 hours per day to sample nocturnal birds and bats. Mist-netting results are expressed as the number of individuals (or species) captured (NCI) per "net-day," defined as the continuous use of a 12-m net for a complete 24-hour period.

Mist-netting provides a quantitative, although biased, estimate of bird relative abundance for species that are regularly active in the understory and lower middle story of the forest. The technique imperfectly samples species that are too large to be restrained by the net and those that are primarily active in the middle or upper forest canopy. Further, it may misrepresent actual measures of relative abundance for some species in the understory, depending upon their average flight distance and social system (Remsen & Parker, 1983; Remsen & Good, 1996). However, given standardization of technique and conditions, as well as exclusion of canopy species, mist-netting data can be useful to measure and compare understory species richness at different sites (Poulsen, 1994).

All birds captured were brought back to the camp in cloth bags, weighed, and measured. A portion of individuals captured were prepared as study skins or anatomical specimens (skeletons or fluid preserved). Those individuals released either were banded with a plastic ring stamped with a unique number or a color sequence or were marked on the feathers with a permanent ink pen.

Census Surveys

Mist-netting data were supplemented with direct observations and auditory identification. Strip censuses were conducted at dawn at Mandena, Petriky, Manafiafy, and Itapera, and results presented are the number of individuals per species per unit length of trail. Such censuses allow for an estimate of relative abundance of bird species, particularly during the breeding season (approximately September to December), when birds are vocalizing. These censuses were conducted at or immediately after dawn until approximately 09h00, the period of maximum vocal activity for many bird species. At the other sites, detailed notes were kept on the birds observed or heard.

During the 1995 expedition to the RNI d'Andohahela data were collected within an altitudinal band \pm 100 m and less than 3 km in horizontal distance from camps, which were established at 440, 810, 1200, 1500, and 1875 m in humid forest in parcel 1 and in spiny forest in parcel 2. Species lists were compiled by direct observation while investigations walked along forest trails, by call-playback of bird calls using a tape recorder, by static observation from broken-canopy watch points, and by mist-netting. Observations from canopy watch points (principally for raptors) were made between 07h00 and 11h00. No suitable site was found for canopy watches at 440 m, but in other elevational zones at least 6 hours of observations were accrued per site. Point counts were made at 150-m intervals (in humid forest) or 200-m intervals (in spiny forest) along marked and measured forest trails. A minimum of 12 point count sites were used within each transect zone. Where possible, 5 point count sites were established at each site in each of the following situations: ridge, slope, and valley bottom.

Each point count site was sampled twice, once between 04h30 and 06h00 and once between 06h30 and 09h00, but never on the same morning. During each sample count, which lasted for 10 minutes, the following data on each bird contact were noted: species, estimated distance from observer (to nearest 10 m), nature of contact (song, call, wing noise, or visual), and time of contact. Densities were calculated using distance estimates for those species for which sufficient data were collected. Estimates of bird densities from the RNI d'Andohahela will be presented in a forthcoming monograph on the 1995 inventory of the reserve.

Habitat Classification

For the analysis of bird habitat preference, we used the following broad categories:

FOREST (F)—Species restricted to continuous tracts of disturbed or intact forest.

OPEN (O)—Species that are found in open areas, including natural openings and *tavy*.

MIXED (M)—Species that use forest and open habitats.

AQUATIC (A)—Species that are found in wetland habitats, including the littoral zone and sea.

Species Classification

For the designation of a species' geographic distribution the following symbols have been used:

* = endemic—species only found on Madagascar.

(*) = endemic to region—species that are restricted to Madagascar, Comoros, and Mascarenes.

N = nesting—species that breed on Madagascar but are not endemic to the island.

M = migrant—species breeding elsewhere but spending the austral summer on Madagascar.

I = introduced—species not native to Madagascar.

Collections and Sight Observations

A considerable amount of previously unpublished information is available in museum collections on the birds of southeastern Madagascar. We have examined material in numerous institutions, and these data have been incorporated herein.

AMNH—American Museum of Natural History, New York.

BMNH—The Natural History Museum, formerly British Museum (Natural History), Tring, United Kingdom.

FMNH—Field Museum of Natural History, Chicago.

MNHN—Muséum National d'Histoire Naturelle, Paris.

NHB—Naturhistorisches Museum, Basel.

SMF—Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main, Germany.

PBZT—Parc Botanique et Zoologique de Tsim-

bazaza (at least in part a portion of the former ORSTOM collection), Antananarivo, Madagascar.

From the time of earliest European colonization, Tolagnaro (Fort-Dauphin) has been an important trading port, and some of the earliest zoological collections to be exported from Madagascar came from there. For example, the first known bird collections made in the Tolagnaro region were by Pierre Poivre in 1756 (Stresemann, 1952). With such early collections, which are usually labeled "Fort-Dauphin," it is not clear if the specimens were actually collected in the immediate surroundings of Tolagnaro or across a broader geographic zone, Tolagnaro merely being the port of exportation. For the sake of simplicity we have cited such material as being from "Fort-Dauphin."

As in so many areas of the island, the initial exploration of remote forested regions of southeastern Madagascar was conducted by the French botanist Henri Humbert, who visited the region in 1928 and in 1933–1934. On the basis of his discovery of intact forest in the mountain zones, part of the Andohahela Forest was designated as a reserve (Humbert, 1941). Subsequently, the size and habitat types represented within the reserve were greatly expanded (Nicoll & Langrand, 1989).

In 1931 Hans Bluntschli visited areas near Amboasary-Sud and near Eminiminy, which was later gazetted as parcel 1 of RNI d'Andohahela (Bluntschli, 1932, 1933). The Bluntschli collections were dispersed to (at least) AMNH, NHB, and SMF (Bluntschli [1951]). The material housed in SMF has been partially described by Dee (1986).

In December 1948 Harry Hoogstraal visited southeastern Madagascar to collect material on vertebrate ectoparasites and to study their importance as disease vectors (Hoogstraal, 1953; Uilenberg et al., 1979). The main focus of his work was mammals, but some bird specimens were collected and sent to FMNH. Hoogstraal visited forests near Tolagnaro, Mandena, and Bemangidy.

In 1971 and 1972 a group of scientists associated with the Centre National de la Recherche Scientifique studied the ecosystems of the Anosyenne Mountains (Paulian et al., 1973). Their report focused principally on the geomorphology, climate, and floristic structure.

Other small research collections made in southeastern Madagascar include those of John G. Williams near Tolagnaro (National Museums of Kenya) and Georges Randrianasolo near Lac Anony and the interior portions of the spiny forest (PBZT). In 1948 Philippe Milon collected birds near To-

lagnaro, Isaka-Ivondro, and at a site "30 km NNW Fort Dauphin," which was in or at the edge of parcel 1 of the RNI d'Andohahela (MNHN). In 1977 Appert (1985) visited the Bemangidy Forest. Specimens taken in 1989 and 1990 during the QIT field work are at FMNH, and some have been transferred to the Service de Paléontologie and Département de Biologie Animale, Université d'Antananarivo.

Rakotondranony's (1977) thesis on the vertebrate fauna of the RP de Berenty, particularly birds, contains numerous records of species previously not reported from southeastern Madagascar (e.g., *Anas bernieri* and *Philepitta schlegeli*) or highly exceptional in the Mandrare River basin (e.g., *Alectroenas madagascariensis* and *Pseudobias wardi*). Because no precise details were presented with his observations and consequently they are not verifiable, we have generally not included these doubtful records within the species accounts.

We also gathered detailed, verifiable, but unpublished information on birds observed by ornithologists and bird-watchers that have visited the region. Observers are identified in the text by their initials:

DT	= David Thorns
DW	= David Waugh
DWo	= David Wolf
FO	= Frank Oatman
GR	= Georges Randrianasolo
IS	= Ian Sinclair
LW	= Lucienne Wilmé
OL	= Olivier Langrand
SJ	= Stig Jensen
SOC	= Sheila O'Connor

Condition of Reproductive Organs and Skull Ossification

Within the species accounts we have often included information on the reproductive state of collected birds based on the condition and development of the sex organs, and age was estimated from skull ossification. This information was used to infer aspects of breeding seasonality, age at first reproduction, and plumage sequences. However, as a caveat, we emphasize that there is not always a clear relationship between size of testes and sperm production, particularly in tropical birds (Moreau, 1936; Snow & Snow, 1964; Foster, 1975). Further, there are also cases of passerines breeding at an unusually early age (often under

extreme environmental conditions) and presumably before complete ossification of the skull (Gibbs et al., 1984).

Systematic Order and Nomenclature

We generally follow the systematic order, nomenclature, and English vernacular names used by Langrand (1990). The Procellariiformes follow Jouanin and Mougin (1979). In a few cases we have deviated from this system. Subspecific determinations are based on our own comparisons of material taken in southeastern Madagascar. In cases when no material was available or patterns of geographic variation are not clear, the subspecific name is presented in brackets. For the scientific names and families of plants (Appendix 2), we have followed Missouri Botanical Garden (1993) and Mabberley (1989).

Malagasy Bird Names

We collected information on the bird names used by local people. In most cases this was done with the bird in the hand or clearly visible to the informant. Some of the difficulties in transcribing names from Malagasy have been reviewed by Langrand (1990, pp. 53–55). In southeastern Madagascar these problems are further exacerbated by the fact that several cultural groups inhabit the region, often each with a variant of the pronunciation or even a totally different name for a given species. An index to local names is presented at the back of this monograph.

In many cases dialectal differences between these groups are not discrete, and rather than presenting names associated with various cultures we present them by locality. The following is a general guide to the cultural group/dialect associated with the various sites from which bird names are presented.

RNI D'ANDOHAHELA (PARCEL 1)—Tanosy.

RNI D'ANDOHAHELA (PARCEL 2)—Tanosy, Tandroy.

BEALOKA—Tandroy.

HAZOFOTSY—Tandroy.

MANAFIAFY—Tanosy.

MANANTANTELY—Tanosy.

MANOMBO—Antaisaka.

MAROSOHY—mostly Tanosy, with some Antaisaka influence.

MAROVONY—Antaisaka, with some Tanosy influence.

RP DE BERENTY (= MALAZA FOREST)—Tandroy.

Malagasy Locality Names

Both French and Malagasy names currently are used for localities in Madagascar. In the vast majority of cases we use the Malagasy name and spellings indicated on Foiben-Taosarintanin'i Madagasikara maps (FTM, Institut National de Géodésie et Cartographie). All locations mentioned in the text are listed in Appendix 1 with respective latitude, longitude, and elevation. We have attempted to include all relevant locality synonyms.

For the sake of brevity we have used abbreviations for the category names of protected areas and several Malagasy governmental organizations.

DEF—Direction des Eaux et Forêts.

JIRAMA—Jiro sy Rano Malagasy.

PN—Parc National.

RNI—Réserve Naturelle Intégrale.

RP—Réserve Privée.

RS—Réserve Spéciale.

Soft Part Colors

Langrand (1990) summarized information on the soft part coloration of Malagasy birds. During our field work in southeastern Madagascar we have been able to supplement this information. Here we provide further details on the soft part colors of birds, based on live or freshly killed birds in the hand. Some information is presented on soft part colors inscribed on data tags of Bluntschli specimens.

Species Accounts

Procellariiformes

Diomedeidae

Diomedea cauta

Shy or White-capped Albatross

A single bird was observed from a promontory, just east of Tolagnaro, on 22 August 1990 (Langrand & Sinclair, 1994).

Diomedea chlororhynchos
Yellow-nosed Albatross

On 16 July 1991, three Yellow-nosed Albatross were observed 15–20 km off the coast of Tolagnaro (IS; Langrand & Sinclair, 1994).

Procellariidae

Daption capense
Cape Petrel

Two Cape Petrels were observed from a ship on 16 July 1991, 15–20 km off the coast of Tolagnaro and in view of land (IS; Langrand & Sinclair, 1994).

Pterodroma macroptera
Great-winged Petrel

A group of eight Great-winged Petrels was observed on 22 August 1990 from a promontory due east of Tolagnaro, and another flock of six was noted on 22 December 1991 from a boat in view of land northeast of Tolagnaro (Langrand & Sinclair, 1994).

Pterodroma mollis
Soft-plumaged Petrel

A group of four individuals was observed on 16 July 1991 from a boat within sight of land and 15–20 km off the coast of Tolagnaro (IS; Langrand & Sinclair, 1994).

Pterodroma baraui
Barau's Petrel

One Barau's Petrel was noted on 22 December 1991 off the coast of Tolagnaro within sight of land (IS; Langrand & Sinclair, 1994).

[*Pachyptila vittata*
Broad-billed Prion

A group of over 30 prions was noted on 16 July 1991 about 15–20 km off the coast of Tolagnaro (IS). They were most likely this species.]

Bulweria fallax
Jouanin's Petrel

On 22 December 1991, two Jouanin's Petrels were observed from a ship at sea northeast of Tolagnaro. The only other record of this species from the region was one individual on 12 January 1992, 130 km northeast of Tolagnaro (Langrand & Sinclair, 1994).

Puffinus pacificus
Wedge-tailed Shearwater

On 2 January 1990, during a cyclone, two Wedge-tailed Shearwaters were observed about 300 m inland at Tolagnaro, and on 20 October a flock of 30 was observed just offshore (SJ). This species has been observed numerous times off the coast of Tolagnaro (Milon et al., 1973; Langrand, 1990).

Puffinus atrodorsalis
Mascarene Shearwater

The only record of this recently described species in southeastern Madagascar was a group of five observed 190 km NE of Tolagnaro on 28 August 1991 (Shirihai et al., 1995).

Podicipediformes

Podicipedidae

Tachybaptus pelzelnii
Madagascar Little Grebe

The Madagascar Little Grebe was rare in southeastern Madagascar. On 7 August 1982 about 20 individuals, all in nonbreeding plumage, were observed on a small pond between Lac Anony and Lac Erombo (OL & LW). This is the only known record from the region.

Pelecaniformes

Phaethonidae

Phaethon aethereus
Red-billed Tropicbird

Milne Edwards and Grandidier (1879) reported that a Red-billed Tropicbird was collected at Tol-

agnaro. The fate of the specimen is unknown to us.

Phalacrocoracidae

Phalacrocorax africanus pictilis Reed Cormorant

The Reed Cormorant has a restricted range in southeastern Madagascar. This species has been observed along the Mananara River, near Hazofotsy, and on the Mandrare River during different times of the year, although it was not common and is not known to breed in this region. Bluntschli collected two individuals near Amboasary-Sud on 22 October (AMNH, SMF). Up to seven individuals, including two juveniles, were observed roosting with *Bubulcus ibis* in trees along the Mananara River in parcel 2 of the RNI d'Andohahela in mid-December.

LOCAL NAME—*Razamboay* (Berenty).

River near the RP de Berenty (OL) and on 20 September near Bevala.

LOCAL NAME—*Fitatry* (Manombo).

Ardeola ralloides Squacco Heron

The Squacco Heron was relatively common in coastal areas. We observed it at Itapera, Mandena, and Petriky. It also was occasionally noted in flooded fields, particularly rice paddies, in the Tolagnaro area, near the RP de Berenty, and Bealoka.

Ardeola idae Malagasy Pond Heron

This species was uncommon in agricultural areas, particularly flooded rice paddy, in the Tolagnaro region. It also was noted along the Mananara River near Hazofotsy, in rice paddies near Amboasary-Sud, and in open areas at the edge of the Marosohy Forest. We have no observation of this species in the region above 350 m.

Ciconiiformes

Ardeidae

Ixobrychus minutus subsp. Little Bittern

The only report of a Little Bittern from the area was a male at Mandena on 20 September. This record could be of nominate *minutus*, a Eurasian migrant to sub-Saharan Africa, or of *podiceps*, the resident subspecies on Madagascar.

Nycticorax nycticorax [*nycticorax*] Night Heron

The Night Heron was noted along coastal river margins, lagoons, and marshes near Manafiafy, Itapera, Mandena, and Petriky. It was generally observed at dusk and dawn. A regularly used roost site was on the east bank of the Mandrare River, 4 km south of Amboasary-Sud, at Bevala. Up to two birds were observed at dusk flying along the Mananara River.

BREEDING—Night Herons nested in the RP de Berenty; at least 10 nests were occupied in early September 1984 and late August 1985. Juveniles were observed on 1 March along the Mandrare

Bubulcus ibis [*ibis*] Cattle Egret

The most common open country ardeid, the Cattle Egret was regularly noted foraging in agricultural areas, particularly rice paddies, in pastureland, often with cattle, in flooded fields, and at the edge of marshes. It was more common in lowland areas below 80 m. Large numbers would search gregariously for insects, particularly orthopterans, on the banks of the Mandrare River. Roosts of up to 30 individuals, including birds in breeding plumage, were noted along the Mananara River in mid-December.

BREEDING—Colonies were found in the RP de Berenty and along the Mandrare River. Apparently this species has an irregular breeding season in this region. On 1 March a colony of about 100 nests, with eggs and young, was found in the trees along the Mandrare River. On 23 December a nearby colony contained about 1,000 active nests (OL). Another colony at Bevala was active with breeding birds between February and March. This species apparently prefers to place nests in *Acacia rovumae*, which are generally the tallest trees in the forest and have the flattest canopy.

LOCAL NAMES—*Vorokotsy* (Manombo), *vorom-potsy* (Manafiafy).

Butorides striatus rutenbergi
Green-backed (Striated) Heron

The Green-backed Heron was relatively uncommon. This species was recorded at Manafiafy, Itapera, near Ranopiso, Lac Anony, and Petriky and along the Mandrare and Mananara rivers. It was relatively uncommon in the area, and most observations are from the edge of freshwater lakes and rivers and brackish lagoons.

BREEDING—A female collected at Manafiafy on 11 October had a shelled egg in the oviduct.

WEIGHT—Female (1), 205 g.

SOFT PART COLORS—Bill: maxilla black, and mandible black along toinia and yellow along base; legs: dull yellow; claws: gray; iris: yellow; orbital ring: yellow.

LOCAL NAME—*Keho* (Manafiafy).

Egretta ardesiaca
Black Egret

The Black Egret was distinctly less common in the area than the Dimorphic Heron. Flocks of up to 30 Black Egrets have been observed in rice paddies between Tolagnaro and Ranopiso. A single individual was observed along the Mananara River in mid-December. There are a few observations of this bird near the RP de Berenty (MP).

Egretta dimorpha
Dimorphic Heron

The Dimorphic Heron was observed in coastal lagoons and freshwater systems near Manafiafy, Itapera, Mandena, and Petriky. To the east of the Anosyenne Mountains, our only records away from the immediate area of the coast are two individuals in a flooded rice field near Enakara at about 140 m and two white-morph birds along the Mananara River. White-morph birds were observed at the RP de Berenty and Bevala, whereas dark-morph birds were occasionally seen at the RP de Berenty but more commonly were found in coastal environments. Of the 19 individuals recorded during the 1989–1990 study seasons, 13 were pure white-morph birds, two were white-morph birds with a few dark flight feathers, and

four were dark-morph birds with white wing patches.

BREEDING—A mixed colony of this species, *Nycticorax nycticorax*, and *Ardea purpurea* was found in July at the RP de Berenty. *E. dimorpha* commenced breeding by mid-August and were on nests with eggs or young by 7 September.

LOCAL NAMES—*Lombokoma*, perhaps generic for large egrets (Manafiafy, Manombo); *mandom bokomana*, perhaps generic for large white ardeids (Marosohy).

Egretta alba melanorhynchos
Great Egret

The Great Egret was relatively common along lowland lakes and streams and in agricultural fields, particularly when flooded, throughout the region. It was noticeably more common east of the Anosyenne Mountains. Generally no more than three or four birds were seen together. An exception was several dozen birds on Lac Erombo on 9 July (OL & LW).

BREEDING—This species also has been found nesting in the RP de Berenty and has been observed along the Mananara River east of Hazofotsy.

Ardea purpurea [madagascariensis]
Purple Heron

The Purple Heron was regularly noted foraging in areas with natural vegetation, including lake margins, coastal lagoons, and swamps, and irregularly noted along the seacoast. It was markedly more common in marsh areas than near open water. Generally single birds were observed, although at dusk on 7 October, near Manafiafy, a group of seven birds was flushed out of a marsh. It was generally observed in lowland coastal areas, but there are inland records from areas such as rice fields near Eminiminy and along the Mandrare and Mananara rivers.

BREEDING—On 24 October a pair of Purple Herons was observed landing in a marsh near Manafiafy; one bird had a stick in its bill. At the RP de Berenty it breeds in mixed colonies with *Nycticorax*, *E. dimorpha*, and *Bubulcus*. At this site *A. purpurea* has been seen on nests with eggs and juveniles in mid-October. Solitary nests have also been found at Bealoka. A single bird was

flushed from a nest along the Mananara River on 9 December.

LOCAL NAMES—*Ragado* (Manafiafy), *rangado* (Manombo).

Ardea cinerea firasa

Gray Heron

The Gray Heron was recorded in a wide variety of habitats, including seashore edge, flooded agricultural fields, lake and river margins, swamps, and coastal lagoons. All of our records are below 100 m. This species was often observed with *E. alba* along the Mandrare River during the dry season, when the river was low. At BMNH there is a Gray Heron specimen collected in the Tolagnaro area before 1891.

BREEDING—A solitary nest of this species was found in the RP de Berenty in an *Acacia* on 21 November.

Ardea humbloti

Humblot's Heron

The Humblot's Heron was rare in the region. We have observed this species at Lac Anony in January (juvenile), late July, and late December. The easternmost record is a single bird on 8 October at the mouth of the Efaho River (upper Lac Andriambe), just west of Tolagnaro. It has been reported a few times from along the Mandrare River near the RP de Berenty, for example in early July (OL & LW) and late September (DW).

Scopidae

Scopus umbretta umbretta

Hammerkop

The Hammerkop was relatively rare in agricultural areas below 350 m. It was occasionally observed in open areas such as along the coastal plain (e.g., Petriky). A vocalizing pair was observed circling over a eucalyptus grove near the Col de Ranopiso, opposite RNI d'Andohahela (parcel 3), in December. This species is also known from the RP de Berenty area (FO). One individual was observed several times along the Mananara River, east of Hazofotsy, in mid-De-

cember. We follow Kahl (1979) in our subspecific designation of the form occurring on Madagascar.

LOCAL NAMES—*Takatry* (Manombo, Marosohy), *takatsy* (Berenty).

Ciconiidae

Mycteria ibis

Yellow-billed Stork

The only record we are aware of for the Yellow-billed Stork in southeastern Madagascar is a flock of 15 just west of Tolagnaro (SJ). The flock was observed in the early morning roosting in some trees next to an extensive area of rice paddies. This species is known to have irregular wanderings around the island (Langrand, 1990).

Threskiornithidae

Lophotibis cristata cristata

Madagascar Crested Ibis

The Madagascar Crested Ibis was relatively common in the majority of the forests visited from the Marovony Forest south through the Anosyenne Mountains to the Manantantely Forest. The highest elevation in the region for this species was recorded at the edge of the Forest of Varavara, not far from Ankepotsy, at approximately 1450 m. Despite regular human persecution, the Madagascar Crested Ibis was still relatively common in the remaining tracts of littoral forest, particularly at Manafiafy, Itapera, and Mandena, and was less common in humid forests. We generally saw single birds or pairs walking on the ground, often on trails, and exceptionally groups of up to seven individuals. This species will cross open areas; for example, in late December an adult was observed flying in the early morning between the Bezavona Forest and the littoral forest at Mandena, a distance of about 1 km. The specimen label of a bird collected near Tolagnaro in 1948 notes, "common in dense secondgrowth forest" (FMNH). This species was absent from Petriky and spiny forest habitat, although it has been reported from the RP de Berenty (Langrand, 1990). It appears to be rare at the RP de Berenty; MP never observed this species there or at Bealoka during the course of over 2.5 years of intensive field work in the mid-1980s.

Local human pressure has apparently been present for at least 400 years (Flacourt, 1658).

People living near Manafiafy and Mandena have a variety of techniques to catch this species. One type of trap is made from a series of approximately 1-m-long sticks that are inserted about 10 cm into the ground to form a spiral funnel trap, the roof of which is closed off with lashed-together *Ravenala* leaves, or the sticks on opposite sides of the structure are angled such that they can be attached to one another. At the closed end of the funnel is a chamber. Apparently, this species is unable to find its way back out of the trap from the chamber. These traps are often placed in areas frequented by this bird, such as narrow trails in the forest. Ground snares were also used in such places to capture this species. We found no evidence that any of these traps were baited. Snares were also used to capture adults sitting on nests by slowly approaching the nest and placing a noose attached to the end of a long stick around the bird's neck. We were told that nesting adults usually do not fly when approached. On 20 December, under a nest in the strand forest of Manafiafy, we found the plucked feathers of an adult Madagascar Crested Ibis. Also, at this same locality a local resident brought us a live ibis that he had captured. Over the course of 4 months in late 1989 evidence was found near Manafiafy of at least five adult *Lophotibis* being captured and eaten. Nestlings and eggs are also removed from nests and consumed. The inaccessibility to humans of portions of the remaining forest and the difficulty of finding nests are presumably the main factors that allow the continued existence of this species in the area.

All specimens examined from the area surrounding Tolagnaro are referable to the nominate subspecies, including birds from Manafiafy, Mandena, and "Taolanaro, Tanosy" (FMNH). Birds occurring in the RP de Berenty area may well be *L. c. urschi*, the subspecies confined to dry western and southern forests (Langrand, 1990).

BREEDING—Near Manafiafy on 24 October an adult was found incubating three eggs in a nest in a *Pandanus* about 6 m off the ground, 100 m from the seacoast, in closed-canopy littoral forest. Nestlings were noted on 10 January near Tolagnaro (MNHN) and on 28 December at Mandena (FMNH).

On 25 October in the strand forest of Manafiafy, about 20 m from the seacoast, two birds were observed displaying to one another. The birds were flushed from the ground, and flew up and perched about 1 m apart on a nearly horizontal branch about 5 m off the ground. Periodically dur-

ing the next several minutes they would bow towards one another, toss back their heads, return the bills to a horizontal position, and then touch bills. This display is similar to that described by Appert (1966). After about 10 such displays one bird flew off. The remaining bird moved around on the limb and uttered a faint, short wailing call. This bird, perhaps disturbed by our presence, then flew farther into the forest. It resumed calling from a new location, but this time it gave a series (up to 8 or 10 notes) of short, harsh notes on one pitch.

In September and October we regularly heard this species calling during the night at various times between dusk and dawn. On several occasions it was observed perched in relatively tall dead trees, often at the forest edge or along a stream, where it would call almost continuously for up to 30 minutes.

DIET—One individual was observed foraging in a small stream bed in a savanna area about 0.5 km from the edge of the Itapera Forest. It was feeding on water invertebrates. In the RNI d'Andohahela, at 400 m, one was seen foraging by probing with its bill 5–10 cm into the bed of a forest stream. A nestling from Mandena had some beetle remains in its stomach, and an adult from near Tolagnaro had "wireworms, centipedes, millipedes + misc. orthop." in its stomach (FMNH).

SOFT PART COLORS—Bill: lime green at base merging to olive at tip, gray with black tip (immature); legs: pinkish red, pinkish yellow (immature); claws: dull black; iris: orangish red, brown (immature); orbital ring: pinkish red, dull yellowish pink (immature).

LOCAL NAMES—*Akoala* (Berenty), *akoholaha-in'ala* (Manafiafy, Marosohy, Marovony), *ako-hon'ala* (Manombo).

Phoenicopteridae

Phoenicopterus ruber [roseus] Greater Flamingo

The Greater Flamingo has been recorded at a number of sites, and their numbers show considerable variation. There is no evidence of this species breeding in southeastern Madagascar. On 30 September 11 adults and 14 immatures were observed on the lagoon near Petriky. Langrand (1990) noted a flock of about 3,000 on Lac Erombo in September. Records from Lac Anony in-

clude six on 7 August (OL), 180 individuals, all adults except four individuals, on 24 December (OL, LW, & SOC), and about 100, all of which were adults save one, on 24 December (the following year). During periods of high water levels this species was rare or absent from Lac Anony. On several occasions it was observed flying over the RP de Berenty.

LOCAL NAME—*Sama* (Manafiafy).

Phoenicopterus minor

Lesser Flamingo

The Lesser Flamingo was less common than the Greater Flamingo in the area. On 9 July about 300 individuals were observed on Lac Erombo (Langrand, 1990; OL & LW). These birds were in small groups of 5–10 individuals, mixed with flocks of *P. ruber*. During this visit flamingos were found for sale as food in a local market. The birds were captured by small nylon nooses placed in the shallows of the lake bottom. This same technique is also used in the Lac Ihotry region (Griveaud, 1960). Records from Lac Anony include seven on 23 March and 59 (all adult) on 7 August (OL & LW).

Anseriformes

Anatidae

Dendrocygna bicolor

Fulvous Whistling Duck

The Fulvous Whistling Duck was seldom encountered. A few individuals were noted along the Andohafasy River, near Manafiafy, and it was rare on the Mandrare River.

Dendrocygna viduata

White-faced Whistling Duck

This species was one of the most commonly observed ducks in the region. The vast majority of records are restricted to the coastal plain. Flocks of up to 200 individuals were noted along rivers, coastal lagoons, flooded fields, and inland lakes. Occasionally it was found in mixed flocks with *Anas erythrorhyncha* of up to 40–50 ducks in total. It was occasionally found in upland areas

up to 350 m. Observations of this species along the Mandrare River are occasional and sporadic.

BREEDING—In mid-December an adult and six downy young were observed along the Andohafasy River near Manafiafy.

LOCAL NAME—*Tsiriry* (Berenty, Manafiafy, Manombo, Marosohy).

Sarkidiornis melanotos

Knob-billed Duck

The Knob-billed Duck was not common in littoral and humid forest areas. On 14 December, three birds were noted at the edge of the Marosohy Forest at approximately 250 m. It also was noted at Manafiafy. In areas west of the Anosyenne Mountains it appears to be more regular, for example along the Mandrare and Mananara rivers. On 26 June 1984, 50 birds were observed on the Mandrare River between Berenty and Bealoka. The distinctive vocalization of this species could be heard in the late afternoon and at dusk over the Malaza and Bealoka forests.

LOCAL NAME—*Ongongo* (Berenty).

Anas melleri

Meller's Duck

Meller's Duck was frequently observed, but only in small numbers, in aquatic areas along the coastal plain, particularly freshwater rivers, shallow lakes, and flooded grasslands up to 50 m. Groups of more than two individuals were seldom noted.

Anas erythrorhyncha

Red-billed Teal

The Red-billed Teal was relatively common, particularly in freshwater habitats below 150 m. Flocks of up to 60 individuals were observed along rivers, lakes, and marshes and rarely in flooded agricultural fields. It was common in coastal lakes and lagoons near Manafiafy, Itapera, Mandena, and Petriky. Along the Mandrare River this species was sometimes observed with *Dendrocygna viduata* and *Sarkidiornis*, but always in small numbers. Up to 55 individuals were observed feeding and roosting along the Mananara River east of Hazofotsy in mid-December. On occasion large concentrations of this species are ob-

served, e.g., over 1,000 individuals on 9 July on Lac Erombo (OL & LW).

LOCAL NAMES—*Boky*, generic for duck (Marosohy); *sadakely* (Manombo).

Anas hottentota

Hottentot Teal

The Hottentot Teal was uncommon. Our only record is two birds on 26 September at Petriky.

Falconiformes

Pandionidae

Pandion haliaetus

Osprey

On 14 February 1988, one Osprey was observed in Tolagnaro (Langrand & Sinclair, 1994). This is the only known record for southeastern Madagascar.

Accipitridae

Aviceda madagascariensis

Madagascar Cuckoo-Falcon

In the humid forests of southeastern Madagascar this species was rare. Records are from the Marosohy Forest (375–900 m) and the Bezavona Forest (75 m). The only other record from humid forest is three individuals displaying together over a ridgeline in primary forest at 810 m in parcel 1 of the RNI d'Andohahela. This latter record was the only observation of this species in humid forests during the nearly 2-month expedition to the reserve, despite a total of 23.5 hours of canopy watches. In comparison, it was relatively common in the dry areas, particularly in gallery forest. This species was observed displaying on four occasions in mid-December in spiny forest near the Mananara River in parcel 2 of the RNI d'Andohahela. Other localities it has been recorded include Lanirano, Andonabe, Ranomainty, Bealoka, RP de Berenty, and Lac Erombo.

The display flight of this species, noted on one occasion, is like that described in Safford and Duckworth's report (1990); a bird turns sideways

TABLE 1. Observations of *Milvus migrans* on morning transects in the Malaza Forest from May 1984 to April 1985 based on 7.3 km of trail surveyed per month.

Month	Total <i>M. migrans</i> observed
1984	
May	20
June	56
July	196
August	75
September	49
October	4
November	0
December	0
1985	
January	1
February	1
March	16
April	18

in flight and makes five or six flickering wing-beats while the wings are pointing up and down.

Machaeramphus alcinus [anderssoni] Bat Hawk

The only records of this species are individuals noted on a few occasions above the Malaza Forest at dusk.

Milvus migrans parasitus

Black Kite

The Black Kite was a common raptor in the open country below 100 m. We regularly observed it over river plains, open fields, and pasturelands and at the edges of small villages. It was exceptional to find this bird within humid forest. This species was more common on the dry western side of the Anosyenne Mountains than on the eastern side. Concentrations of Black Kites are not uncommon in the spiny forest region, particularly in trees along river margins. A specimen (AMNH) was taken by Bluntschli on 26 October near Amboasary-Sud.

At certain times of the year large concentrations of this species were noted in the Malaza Forest and along the Mandrare River, and this species was most common during the winter months between June and September (Table 1). Up to 30 individuals have been found perching in a single tree along the Mandrare River near the RP de Ber-

enty, and hundreds may be seen at the same time cooling off in the river.

DIET—At the RP de Berenty this species provokes antipredator behavior in the Ring-tailed Lemur (*Lemur catta*) and Verreaux's Sifaka (*Propithecus verreauxi*) (Sauther, 1989; Goodman et al., 1994b), although there is no direct evidence that it attacks either species. Further, these two lemurs respond much less frequently to the passing of *Milvus* overhead than to *Polyboroides* and *Buteo* (A. Jolly, pers. comm.). It has been observed at this locality taking young *Bubulcus* from nesting colonies, particularly those that fall from nests, and young chickens in nearby villages. Pellets contained beetle parts and larval stages of Lepidoptera. Also, it was observed consuming grassland invertebrates, particularly grasshoppers and locusts. At Lac Errombo this species was observed feeding on large colonial spiders and near the RP de Berenty following plows in sisal plantations (OL & LW). The favored perches for hunting and roosting are *Acacia rovumae*, *Tamarindus*, *Neotina isoneura*, *Quivisanthe papinae*, and *Albizia polypylla*, all of which are canopy trees.

BREEDING—In the Malaza Forest and perhaps throughout much of southeastern Madagascar, this species may breed in the austral winter; birds have been observed copulating in July. Further, this species was all but absent from the forest between October and February. The few birds observed during this latter period, which coincides with the breeding season of most bird species, were severely harassed by *Accipiter* spp., *Falco newtoni*, *Eurystomus*, *Vanga*, and *Dicrurus*.

LOCAL NAMES—*Papango* (Manafiafy), *tsimala* (Berenty).

Polyboroides radiatus Madagascar Harrier Hawk

The Madagascar Harrier Hawk was found in a variety of habitats throughout the region, including littoral, lowland, and montane forests, and in spiny forest from sea level to about 1000 m. It was less frequently observed in heavily disturbed open habitats, although in dry areas it was often seen perched in open disturbed woodland. It breeds in disturbed and fragmented forests surrounded by sisal plantations as long as there are appropriate nesting trees (e.g., *Adansonia*). *Polyboroides* was not observed over humid forest during 23.5 hours of canopy observation in parcel 1

of the RNI d'Andohahela but was seen in degraded savanna habitats just outside the reserve at Isaka-Ivondro and over spiny forest in parcel 2 of the same reserve.

DIET—Langrand and Meyburg (1984) noted that in the Tolagnaro area this species forages in open areas on the ground, particularly around stones, cow dung, termite mounds, and rotten tree stumps. "Before completely shifting or overturning a lump of cow dung or a stone, the bird would peer beneath it presumably to take cockroaches and beetles by surprise" (1984, p. 11). In the RP de Berenty *Polyboroides* is known to feed on flying fox (*Pteropus rufus*) (Goodman & Pidgeon, 1991) and at Bealoka on Sakalava Weavers (*Ploceus sakalava*). It also will pull back the bark from tamarind and acacia trees, hanging on with one leg and bracing with the wings as it probes crevices in trees with the other leg. This species also uses termite mounds as hunting perches (OL).

BREEDING—At least three *Polyboroides* nest sites were active in the RP de Berenty at the same time, where on 5 September an adult was observed adding sticks to a nest used the previous breeding season, and on 23 December of the same year the nest contained a bird about ready to fledge. Nests, usually placed in baobab (*Adansonia*) or acacia (*Acacia rovumae*), are reused in consecutive years. Copulations have been observed in late December. The Madagascar Harrier Hawk often nests close to *Ploceus sakalava* colonies, which often are in or near villages. The tolerance of *Polyboroides* by Tandroy or Mahafaly villagers could mean that rigid taboos remain intact or that they have a complete indifference to this hawk.

SOFT PART COLORS—Bill: black; legs: yellow; iris: yellow.

LOCAL NAMES—*Fihiaaka* (Berenty), *fileliakondro* (Manombo).

Circus maillardi Réunion Harrier

The Réunion Harrier has been observed only on few occasions in southeastern Madagascar. One was recorded about 5 km west of Tolagnaro on 27 April 1988 (DT), and a single subadult was noted in a marshy depression just west of Tolagnaro on 27 September 1990 (DWo).

Accipiter henstii

Henst's Goshawk

Henst's Goshawk was observed and heard regularly in parcel 1 of RNI d'Andohahela in October–December in the 440-m and 810-m transect zones. During this period, only one individual was seen (810 m) during 23.5 hours of canopy watches. Most individuals were detected by their distinctive vocalization. In almost all cases (as with observations elsewhere in Madagascar) this call was heard from single birds. However, on 22 October (440 m) two birds, of unknown sex, flew along the same line about 500 m apart, both calling loudly.

On 25 October in parcel 1 of the RNI d'Andohahela, a male Henst's Goshawk apparently was following a mixed species flock, containing at least *Tylas eduardi*, *Cyanolanius madagascarinus*, *Calicalicus madagascariensis*, and *Terpsiphone mutata*. The hawk was climbing clumsily up dense vegetation on the side of a tree, toward the feeding flock. Many of the birds gave alarm calls. On sighting the observer, the raptor flew off.

Accipiter madagascariensis

Madagascar Sparrowhawk

The Madagascar Sparrowhawk was recorded in the humid forests of Marovony and Marosohy between 50 and 440 m. It also occurs in the spiny forest sites such as the RP de Berenty, Bealoka, and parcel 2 of the RNI d'Andohahela, primarily in gallery forests.

DIET—On 12 December an adult Madagascar Sparrowhawk was netted in the Marosohy Forest at 375 m with a fledgling *Copsychus albospecularis* in its talons. At the RP de Berenty, *Hypsipetes madagascariensis* form an important portion of this species largely avian diet.

BREEDING—At the RP de Berenty one pair nested in the same *Acacia rovumae* tree over the course of 4 years. In 1983 and 1984 this nest produced three and four young, respectively.

WEIGHT—[Female] (1), 285 g.

Accipiter francisii francisii

Frances's Sparrowhawk

The Frances's Sparrowhawk was one of the most widely distributed raptors. It was found from

sea level to about 1600 m and in a variety of habitats from pristine humid, gallery, and spiny forest, to open pastureland with small forested islands, to *Eucalyptus* plantations. It was noted on a few occasions in the city of Tolagnaro and at Lanirano. In 1931 an individual was collected in Amboasary-Sud (SMF).

Of the six individuals netted in 1989 and 1990, five were males and one was a female. In most cases it appeared that the hawk was attracted to the net by a struggling captured bird. Although our data are limited, this bias might reflect a difference in the hunting techniques between the sexes, as is known for other members of this genus (Storer, 1966). For example, males might hunt lower in the forest strata or feed more on small passerine birds.

During the 1995 mission to the RNI d'Andohahela this raptor was seen at 440 m, 810 m, and 1500 m in humid forest habitat. It was only seen twice at 1500 m during a total of 23.5 hours of canopy watches. A male at 1500 m called from the top of an 8-m dead tree on a ridgeline at about 11h00. The call was a loud repeated single note, "whick." This same call was heard at 440 m.

DIET—Stomachs of specimens taken in the Tolagnaro area contained spiders (Acari, Araneae), beetles (Carabidae, Scarabaeidae), grasshoppers (Acrididae), crickets (Gryllidae), cicadas (Cicadidae), Mantodea, Odonata, ants (Formicidae), and reptile and bird remains (Goodman & Parrillo, in press). An adult male Frances's Sparrowhawk was captured at the Marovony Forest after it attacked a *Zosterops* tangled in a mist net. At the RP de Berenty *A. francisii* feeds on skinks and geckos, primarily *Phelsuma*, *Lygodactylus*, *Mabuya*, and probably *Tracheloprychus*, and occasionally on birds such as *Acridotheres tristis*. The capture technique for saurians involves flying straight toward the prey and knocking or grabbing them from tree trunks, and standing motionless on riverbanks and flying down to lower ground to attack prey.

BREEDING—A female netted on 10 October at Manafiafy had ovarian follicles 14×7 mm and a thickened oviduct. Males collected in September and in early to late October at various localities had testes up to 12×5 mm. In October an adult rigorously defended a presumed nesting site near Manafiafy and would dive-bomb passing humans, and on one occasion a bird actually made contact. A parallel type of territory defense was observed in the spiny forest east of Hazofotsy. At the RP de Berenty this species breeds in *Acacia*, *Celtis*,

and *Tamarindus* trees, where they place their cup-shaped nests at the top of the bole where the primary branches bifurcate; *Accipiter madagascariensis* generally places its nests higher up and in more open trees. Nestlings of *A. francesii* have been observed during late December and January. On 6 August a pair was noted in the gallery forest along the Mandrare River performing display flights.

WEIGHT—Female (1), 162 g; male (5), 111.0 ± 4.8 (104–116) g.

SOFT PART COLORS—Bill: maxilla black with a bluish gray tomia, and mandible black with bluish gray base; cere: dull greenish yellow; legs: dull yellow; iris: deep yellow; orbital ring: orange yellow.

LOCAL NAMES—*Fandraokibo* (Berenty), *tsipara* (Manafiafy), *tsipara korovana* (Marosohy).

Buteo brachypterus Madagascar Buzzard

The Madagascar Buzzard was observed at virtually every site visited and in a variety of habitats from near sea level to 1950 m, including primary, relatively intact and degraded humid and spiny forest, gallery forest, and open areas such as pastureland or agricultural fields near the forest edge. Single individuals or pairs were generally noted.

This species was recorded from 440 m to 1950 m in parcel 1 of the RNI d'Andohahela, where it was the most common raptor. During canopy watches it was seen on average every 2.2 hours at 810 m, every 1.8 hours at 1200 m, every 1.0 hours at 1500 m, and not at all during 5 hours at 1900 m. No suitable canopy watchpoint was located at 440 m.

DIET—In the Ankapoky Forest an adult Madagascar Buzzard was observed removing a *Streptopelia picturata* from a mist net and consuming the head. At Petriky, a Madagascar Buzzard was noted feeding on a mouse-size lizard (probably a *Zonosaurus*). In an open agricultural area below the Marosohy Forest we observed an adult buzzard flying off with a relatively large snake in its talons. At the edge of the Analalava Forest we noted an adult buzzard dismantling a chameleon between 250 and 400 mm long. The bird removed the head and swallowed it before alighting with the prey on a nest containing two young. In the RP de Berenty, an adult buzzard brought a young egret back to the nest. Both *Propithecus verreauxi*

and *Lemur catta* give predator alarm calls when this raptor is heard or seen nearby.

BREEDING—On 5 November a pair of Madagascar Buzzards was found attending a nest with two downy young at the edge of the Analalava Forest. In late October of the following year the same nest was occupied by a breeding pair. On 15 November in the spiny forest near Hazofotsy, an adult was apparently brooding the contents of a nest. At the RP de Berenty, this species prefers to nest in the canopy of tall emergent trees, such as *Acacia rovumae*, *Tamarindus*, and *Neotina isoneura*, and they reuse the structure from year to year. At this site fledglings have been observed in January. A pair of *Newtonia brunneicauda* nested in the bottom of an active buzzard nest. In the spiny forest nests are often placed in large *Alluaudia* trees.

In the humid forests of parcel 1 of the RNI d'Andohahela at least four pairs occupied territories along the Andranohela River between Trafonaomby and the forest edge near Eminiminy. A single individual was seen at 1950 m on 30 November carrying a small branch. Displays (birds soaring high followed by steep dives and wingflapping) were noted in all altitudinal zones within the humid and spiny forests of the reserve between 18 October and 12 December.

SOFT PART COLORS—Downy nestling. Bill: black; cere: dull grayish blue, legs: off-white with slight bluish cast; claws: black; iris: dark tan.

LOCAL NAMES—*Hindry* (Andohahela), *hondria* and *bevorotse* (Berenty).

Falconidae

Falco newtoni newtoni Madagascar Kestrel

The Madagascar Kestrel was one of the most common raptors. This species was generally recorded in open areas such as agricultural fields, pastureland, and gardens or at the forest edge from near sea level to 900 m. It was seldom noted in areas of intact humid forest but apparently penetrates such habitat along open river channels. For example, our only record of this species in the Marosohy Forest was near a river cascade at 375 m. *F. newtoni* was common in spiny forest and adjacent degraded savanna in parcel 2 of the RNI d'Andohahela.

DIET—The stomach of a bird collected “30 km NW Fort-Dauphin” contained insect remains

(MNHN). In the RP de Berenty this species feeds mostly on grasshoppers, cockroaches, locusts, and skinks and occasionally on small birds.

BREEDING—In the RP de Berenty *F. newtoni* often places its nest in holes in or at the top of broken-off trunks of *Acacia rovumae* and in open buildings and on ledges. In Tolagnaro a pair nested on the post office tower. Adults are very vocal during breeding, calling to one another when returning to the nest with prey. Fledglings have been noted between late November and early January.

WEIGHT—Male (1), 85 g.

SOFT PART COLORS—Bill: gray at base merging to black tip; cere: yellow; legs: yellow; claws: black; orbital ring: yellow; iris: brown.

LOCAL NAMES—*Rehitriky* (Berenty), *hitsikitsika* (Manafiafy), *hitsikitsiky* (Manombo, Marosohy).

Falco zoniventris Banded Kestrel

All of our records of this species in southeastern Madagascar are confined to spiny forest, although in other areas of the island it also is found in humid forest (Langrand, 1990). In the Ankapoky Forest, the Banded Kestrel was relatively common. Individuals would often be noted perched in tall baobabs or other trees with good vantage points, from which they would sally out and capture prey in the air. This species was regularly observed in the RNI d'Andohahela (parcel 2), where it nests. This species also occurs in the RP de Berenty, Bealoka, and in nearby sisal plantations. Occasionally it is seen in open landscapes, perched on scattered sisal plants kilometers from the nearest forest.

DIET—Two or three pellets collected below a perch in the Ankapoky Forest contained insect remains and the bones of at least two *Ploceus sakalava*. In the Malaza and Bealoka forests this species sometimes hunts from sisal inflorescences at the ecotone between forest and plantation.

BREEDING—In parcel 2 of the RNI d'Andohahela, an adult Banded Kestrel called in an *Alluaudia* tree for 20 minutes while holding an *Oplurus* lizard in one foot. The call consisted of a quiet “kwik . . . [repeated in a series and then ending with] . . . tsit-tsit-tsit,” the latter three notes rising slightly. Another individual perched about 100 m away was silent.

Falco eleonorae Eleonora's Falcon

This Palearctic migrant was not common. An immature individual was observed on 8 December over parcel 2 of the RNI d'Andohahela, and an adult was observed on 23 December at Petriky. On 2 March three individuals were observed in parcel 3 of the RNI d'Andohahela with *F. concolor* (OL). The earliest known date of arrival in the region is 19 November in the Bealoka Forest.

Falco concolor Sooty Falcon

Both the Sooty Falcon and Eleonora's Falcon are boreal winter migrants to Madagascar. Unlike Eleonora's Falcon, Sooty Falcons can at times be relatively common in inland open areas. For example, on 19 November at Bealoka 12 individuals were observed along one path. The earliest date of arrival in the area is 19 October (SOC) and the latest date of departure is 7 May.

DIET—The boreal autumn arrival of this species in the dry areas of southeastern Madagascar generally coincided with cicada emergence. This falcon perches on exposed dead trees or sisal inflorescences close to the forest edge overlooking the floodplain and robs sphecid wasps (*Sphecius grandidieri*) of their cicada prey by swooping at them. In April or May, before the falcons depart to northern breeding grounds, they will feed on *Foudia madagascariensis* during a period when invertebrate availability is declining. On 1 March *Falco concolor* was observed along the Mananara River, near Hazofotsy, capturing dragonflies on the wing (OL).

Falco peregrinus [radama] Peregrine Falcon

The Peregrine Falcon was rare. On 9 December one was observed in the Marosohy Forest, at the edge of the RNI d'Andohahela (parcel 1), at about 375 m. From an open vantage point along the Tsi-tongatona River a Peregrine Falcon, perhaps the same individual, was noted flying above the canopy and alighting on a large and slightly white-washed rocky outcrop high along the steep river valley. It is possible that the outcrop was an aerie. On 7 July a Peregrine Falcon was observed in the village of Ebelo, 60 km north of the RP de Ber-

enty (OL). Nearby is the cliff of Vohitsiombe, where this species might breed. Between October and December it was observed in the sisal plantations bordering the RP de Berenty.

DIET—In November and December 1986 a Peregrine Falcon regularly attacked chickens in the village of Hazofotsy. Rand (1936) reported several incidences of this species feeding on domestic fowl, a prey type that is rarely taken by Peregrine Falcons on the African continent (Brown et al., 1982). Adjacent to the Bealoka Forest this species has been observed on two occasions feeding on *Streptopelia picturata*.

Galliformes

Phasianidae

Margaroperdix madagascarensis

Madagascar Partridge

The Madagascar Partridge was recorded at a variety of sites from near sea level to about 1700 m. It was a common species, although because of its skulking habits in relatively dense grassland it was often difficult to see. When disturbed, it flew reluctantly and only for short distances. It was generally found in open grassland or heath habitat throughout this area, even on steep slopes. At least four individuals were present in degraded areas below Trafonaomby adjacent to a marsh between 1550 and 1700 m.

DIET—A female caught in a mammal trap baited with peanut butter and rice at Mandena had small seeds in its stomach.

BREEDING—The Mandena specimen's ovary was slightly enlarged (20 × 8 mm), and the largest ovarian follicle was 3 mm.

WEIGHT—Female (1), 250 g.

SOFT PART COLORS—Bill: maxilla black, tomia basally bluish gray, and mandible bluish gray with black tip; legs: light gray with darker scute edges; iris: dark reddish brown.

LOCAL NAME—*Traotrao* (Manafiafy, Manombo, Marosohy).

Coturnix coturnix [africana]

Common Quail

The Common Quail has been reported in the RP de Berenty (Langrand, 1990). No other re-

cords of it are known from southeastern Madagascar (Langrand & Appert, 1995).

Numididae

Numida meleagris mitrata

Helmeted Guineafowl

The Helmeted Guineafowl was a relatively common bird of open habitat, particularly damp marshes, grasslands, pasture, river edge, and the edge of degraded humid and spiny forest from near sea level to 325 m. It also has been regularly observed in sisal plantations. Occasionally large groups are seen, e.g., up to 40 individuals at the edge of gallery forest north of the RP de Berenty (OL). During the dry season considerable numbers of this species are noted foraging in sweet potato fields along the Mandrare River bed. It often visits water sources at dawn and dusk. Specimens taken at Eminiminy on 12 October (AMNH) and 12 November at "Taolanaro, Tanosy" (FMNH) are referable to the form *mitrata*.

This species is regularly hunted by local inhabitants of the area, who use a variety of traps and snares to capture it. The Madagascar population of this species cannot be distinguished from east African populations, and local birds presumably were introduced to the island.

LOCAL NAME—Akanga (Berenty, Manafiafy, Manombo, Marosohy).

Gruiformes

Mesitornithidae

Mesitornis unicolor

Brown Mesite

The Brown Mesite was found in humid forests at Marovony, Analalava, Bezavona, Marosohy, and Manantantely from 50 to 810 m. It apparently prefers closed-canopy forest with a relatively open understory and was more common below 100 m. This species was not detected, however, during the 1995 mission to the RNI d'Andohahela, despite 7 weeks of intensive field work in the humid forest of parcel 1. Appert (1985) noted this species at Bemangidy, which is the same site where Hoogstraal found this species and collected two nests (FMNH), one on 24 November and the

other on 25 December. Each nest contained a single egg, within 2 m of the ground, and placed in the fork of a sloping tree (Rand, 1951).

In late October in the Analalava Forest and in late September in the Manantantely Forest this species was very responsive to playback recordings. On one occasion, recordings were played in an open area about 30 m from the forest edge after a bird was heard calling from somewhere inside the forest. In response, a pair of birds approached to within only a few meters of the recorder and observers, even though they were at the edge of the forest. Only one member of the pair called; in response to further playback, this bird climbed up a fallen log and continued calling from this perch, about 1 m off the ground.

DIET—The stomach of the bird taken in the Analalava Forest contained spiders (Araneae), gastropods, cockroaches (Blattodea), beetles (Chrysomelidae, Curculionidae, Elateridae, Scarabaeidae), and ants (Formicidae) (Goodman & Parrillo, in press). Appert (1985) noted that the diet of this species and *Canirallus kiolooides* might be similar in the Bemangidy Forest, and that these two species might compete for resources.

BREEDING—A female collected at Analalava Forest on 7 November had a shelled egg in the oviduct and two corpora lutea.

WEIGHT—Female (1), 148 g (with shelled egg in oviduct).

SOFT PART COLORS—Bill: maxilla dark brown, and mandible dark yellow at base merging to brown; legs and claws: greenish brown; iris: brown.

Turnicidae

Turnix nigricollis

Madagascar Button Quail

The Madagascar Button Quail was recorded at a variety of sites from near sea level to 1700 m. This species was relatively common in open grassland, heathland, and littoral and spiny forest and at the edge of humid forest. It was common in areas that offer cover ranging from grassland and secondary growth with weeds to closed-canopy gallery forest with thick leaf litter. Populations continue to exist in heavily disturbed areas, e.g., the littoral forest near Lac Lanirano on the outskirts of Tolagnaro. In open grasslands this species was often sympatric with the Madagascar Partridge. *Turnix* were collected near Eminiminy

on 30 September (AMNH, SMF) and reported from Bemangidy (Appert, 1985). Single adults were seen twice in open grassland adjacent to sclerophyllous forest at 1700 m near Trafonaomby.

Throughout its range this species is subjected to local hunting pressure. A variety of walk-in type traps are used to capture it, as are slingshots.

DIET—The stomach of a bird collected at Mandena had Gastropoda, Blattodea, beetles (Curculionidae, Elateridae, Scarabaeidae, Tenebrionidae), flies (Asilidae), Hemiptera, and Lepidoptera (larva) remains in its stomach (Goodman & Parrillo, in press). While searching for food in the soil or leaf litter this species makes a distinctive small circular or conical scrape about 9–10 cm in diameter, which is diagnostic of this species' local presence.

BREEDING—Downy young were found on 9 September at Mandena, on 9 October at Ankapoky, and on 9 April at the RP de Berenty.

WEIGHT—Female (3), 59, 72, 80 g; male (2), 60, 72 g.

SOFT PART COLORS—Bill: dull bluish gray, light bluish gray, and black (downy); legs: whitish gray, pinkish gray blue, and brownish gray (downy); iris: pale cream white, light grayish white, and brown (downy).

LOCAL NAME—*Kibo* (Berenty, Manafiafy, Manombo, Marosohy).

Rallidae

Rallus madagascariensis

Madagascar Rail

Three specimens at FMNH collected at Bemangidy in late November by H. Hoogstraal are the only known records of this species from southeastern Madagascar. According to the specimen labels the birds were collected "in forest."

LOCAL NAME—*Kiky* (Manombo).

Dryolimnas cuvieri cuvieri

White-throated Rail

This species was relatively common in marshes, lake edges, or low-lying areas within or near to littoral and humid forest from the Marovony Forest south to Marosohy, Mandena, and Bezavona. Appert (1985) reported this species from the Bemangidy Forest. It was more common in littoral forests than in upland humid forests and could

be found in close proximity to villages. The highest elevation at which we recorded this species was in the Marosohy Forest at 900 m. During the 1995 mission to the RNI d'Andohahela it was found in humid forest at 440 m in dense vegetation along the Andranohela River but not at higher elevations. This species was relatively rare along the river margins in the region west of the Anosyenne Mountains, although it is known from areas where there is sufficient *Phragmites* cover such as along the Mananara River and near Ranopiso.

DIET—Stomachs of collected individuals contained insect remains, including Araneae and Scarabaeidae (Melolonthinae), and seeds (Goodman & Parrillo, in press).

BREEDING—Adult females collected at Mandena on 11 September and at Manafiafy between 9 and 13 October had ovaries up to 15×7 mm, slightly to greatly thickened oviducts, and ovarian follicles up to 6 mm in diameter. Two adults and three juveniles were found in the Malaza Forest on 21 January during a period of high water.

WEIGHT—Combined (5) 232 ± 34.4 (200–290) g.

SOFT PART COLORS—Bill: distal two-thirds brownish gray or black merging to pink or orange base; legs: olive gray, brownish gray, or dark brown; claws: dark brown or black; iris: reddish orange, reddish brown, or orange crimson.

LOCAL NAME—*Tsikoja* (Manafiafy).

Canirallus kioloides kioloides Madagascar Wood Rail

The Madagascar Wood Rail was found in intact closed-canopy humid forests at Marovony, Analalava, Marosalohy, Marosohy, parcel 1 of the RNI d'Andohahela, Bezavona, and Manantantely between 50 and 1950 m and in the littoral forest of Itapera at about 20 m. It was also known from Bemangidy (Appert, 1985; FMNH) and Eminiminy (AMNH). Specimens in FMNH from Analalava and Bemangidy are referable to *Canirallus k. kioloides*.

In the months of October through December we found this species to be very responsive to tape playback, and several times two adults followed by young would approach the tape recorder. In one case in the Marosohy Forest, at about 475 m, two separate pairs were called in from opposite directions to a site that appeared to be a territory boundary.

DIET—The stomach of a collected bird contained remains of Chilopoda, Diplopoda, Hymenoptera, Isoptera, and Orthoptera (Goodman & Parrillo, in press).

BREEDING—A male taken on 9 November in the Analalava Forest had testes 9×3 mm (left) and 4×2 mm (right). On 10 November in the same forest a pair was observed with two young that lacked white throats. In the Marosohy Forest, at 800 m on 30 November, two adults were noted with two downy young. A pair with three young was observed in humid forest of parcel 1 of the RNI d'Andohahela at 700 m on 18 October.

WEIGHT—Male (1), 172 g.

SOFT PART COLORS—Bill: bluish gray proximally merging to dull yellow tip; nasal operculum: brownish gray; legs and claws: black; iris: brown.

Sarothrura insularis

Madagascar Flufftail

The Madagascar Flufftail was recorded between 20 and 1950 m in a variety of habitats, including grasslands (*safaka*) and humid forest (e.g., Marosohy Forest and various places in the RNI d'Andohahela, parcel 1). It is also known to occur in the savannah areas near Eminiminy and Vohibaka. In high-elevation zones this species was noted in areas of humid vegetation under dense canopy, sometimes considerable distances from running or standing water.

LOCAL NAME—*Biriky* (Andohahela, parcel 1).

Gallinula chloropus [pyrrhorhoa] Common Moorhen

The Common Moorhen was infrequently encountered. Most of our records are from marshes at the littoral forest edge and coastal lagoons. On a few occasions this species was observed in flooded rice fields in the Tolagnaro area, including near Mandena and Petriky. At least four pairs were present along a 2-km stretch of the Mananara River in parcel 2 of the RNI d'Andohahela in December. They only occurred in areas with dense reed beds.

LOCAL NAME—*Taleva* (Marosohy).

Porphyryla allenii Allen's Gallinule

On 30 September 1990 a single adult Allen's Gallinule in breeding plumage was observed west of Tolagnaro in a marsh near the îlot des Portugais (DWo). This is the only known record from the area.

Porphyrio porphyrio [madagascariensis] Purple Swamphen

The Purple Swamphen was relatively uncommon. The vast majority of our records are from large marshes adjacent to littoral forest, e.g., at Manafiafy and Mandena. This species also has been reported in the RP de Berenty (Langrand, 1990).

LOCAL NAME—*Talevana* (Manafiafy, Manombo, Marosohy).

Fulica cristata Red-knobbed Coot

The Red-knobbed Coot was noted on a few occasions. Observations include five individuals on 9 July on Lac Erombo and one individual on 1 August on a pond between Lac Erombo and Lac Anony (OL & LW); most of these records involved birds with bright red casques.

Charadriiformes

Jacanidae

Actophilornis albinucha Madagascar Jacana

The only record we have from the area is two males taken near Amboasary-Sud on 22 October 1931 by Bluntschli (AMNH, SMF). This is a considerable range extension; the closest known previous locality for this species was in southwestern Madagascar (Langrand, 1990). We know of no more recent evidence of this species in southeastern Madagascar.

SOFT PART COLORS—Bill: bluish gray; legs: bluish gray; iris: olive brown.

Rostratulidae

Rostratula benghalensis [benghalensis] Greater Painted Snipe

The Greater Painted Snipe was only recorded a few times. On 31 October one bird was noted near dusk in a rice field just below Antseva (800 m), on 10 October several individuals were observed after dark in a flooded field near Manafiafy, and on 7 October one bird was recorded along the Mandrare River at the RP de Berenty.

Glareolidae

Glareola ocularis Madagascar Pratincole

The Madagascar Pratincole, a migratory species that spends the austral winter in East Africa, was observed on numerous occasions in lowland areas between Bemangidy and Mandena. Our earliest record is from 22 September at Pointe Evatra. Generally small groups were observed in open fields or "heathland," often in areas with rocky outcrops. The largest concentration observed in the region was a flock of 15 birds on 28 October resting on a rocky outcrop 40 km south of Manantenina. Between 14 and 16 October, two pairs were observed resting on a sandy island in a coastal lagoon near Itapera. No nests were located in the region, but the birds apparently were territorial and were suspected of breeding. In early October Bluntschli found this species near Eminiminy (approximately 300 m) and collected several specimens (AMNH, NHB, SMF).

SOFT PART COLORS—Bill: blackish brown; legs: black; iris: reddish brown.

Charadriidae

Pluvialis squatarola Black-bellied Plover

This migrant from Eurasia was noted on several occasions along the seacoast. The majority of our records are from the Manafiafy area, and the earliest date of arrival is 10 September.

Charadrius hiaticula [tundrae]

Common Ringed Plover

This Eurasian migrant was relatively common along the sandy beaches from Manantenina to Tolagnaro. Our earliest date of arrival was mid-October. Flocks of up to a few hundred were observed. *Tundrae* probably is the form visiting the region.

LOCAL NAME—*Salaly kely*, generic for small shorebird (Manafiafy).

Charadrius thoracicus

Madagascar Plover

This species was observed in the coastal lagoon near Itapera. In mid-October 1990 at least eight pairs were noted in the area.

BREEDING—A downy young was collected on 19 October at the edge of Lac Mananivo near Itapera.

SOFT PART COLORS—Downy young. Bill: base lime green merging to brownish black tip; legs: dull lime green; claws: black; iris: brown; skin color over most of body: slate to black.

Charadrius pecuarius pecuarius

Kittlitz's Plover

Kittlitz's Plover was relatively common below 50 m elevation in grassland or sandy areas adjacent to fresh or saline lakes and marshes, e.g., Manafiafy, Petriky, and Lac Anony. On several occasions we found this species in recently burned grassland fields, and it appears to be one of few ground-dwelling species that utilizes this habitat. Kittlitz's Plover was the most common small plover on the lower Mandrare River. It congregates along the shores of Lac Anony during seasonal periods of low water. Bluntschli collected three specimens at Amboasary-Sud on 10 November (AMNH, SMF).

BREEDING—On 16 October downy young of this species were found at the unvegetated edge of a lagoon near the Itapera Forest. At this same site *C. thoracicus* also was nesting, but this species appeared to prefer the slightly higher areas adjacent to the lagoon being used as cattle pasture.

SOFT PART COLORS—Downy young. Bill: black; legs: yellowish brown; iris: brown.

Charadrius tricollaris [bifrontatus]

Three-banded Plover

On 1 November an adult Three-banded Plover was observed at the edge of the Marovony Forest along a streambed in a grassland area. The bird was feeding in the shallows of the stream at the edge of a rock cascade. It also has been noted on 7 July along the dry margins of the Mandrare River, near the RP de Berenty (OL). In general this species is rare in eastern Madagascar (Langrand, 1990).

Charadrius leschenaultii

Greater Sand Plover

The Greater Sand Plover was observed on a few occasions, generally along the seacoast or slightly inland at lakes or lagoons. The earliest records are from early October. Flocks of up to 15 individuals have been recorded at sites such as Mandena, Lac Anony, and Lac Andriambe.

Charadrius marginatus tenellus

White-fronted Plover

The White-fronted Plover was rare. This species has been observed at Lac Anony on numerous occasions, where it tended to occur in non-flooded sandy areas, often mixed in with groups of *C. pecuarius*.

DIET—The stomach contents of four specimens taken at Lac Anony contained marine crustaceans and fine stones (PBZT).

Scolopacidae

Limosa lapponica lapponica

Bar-tailed Godwit

The Bar-tailed Godwit, a Eurasian migrant to Madagascar, was uncommon during the boreal winter along coastal beaches. One individual, referable to the nominate form, was collected in mid-October at Pointe Evatra (FMNH). The bird was killed by a local boy with a slingshot. Our earliest date for the region was 7 October at Manafiafy.

LOCAL NAME—*Salaly be*, generic for large shorebirds (Manafiafy).

Numenius phaeopus

Whimbrel

The Whimbrel, a Eurasian boreal winter migrant to Madagascar, was relatively common, but never in groups exceeding three individuals, along coastal beaches (e.g., Manafiafy, Itapera, and Pointe Evatra) and lakes (e.g., Lac Anony). We have no far-inland records of this species from southeastern Madagascar. It was observed between late September and late October.

Numenius arquata [orientalis]

Eurasian Curlew

This Eurasian migrant to Madagascar during the boreal winter was observed on a few occasions along the seacoast near Itapera and Manafiafy. The earliest records are from late September.

Tringa nebularia

Common Greenshank

Small numbers of Common Greenshank were noted on several occasions between September and December. This Eurasian migrant to Madagascar during the boreal winter was generally observed on inland freshwater lakes or coastal lagoons, e.g., Manafiafy, Itapera, and Mandena. This species and the next are the two most common species of waders in southeastern Madagascar; during this period they are also found on inland rivers such as the Mandrare and Mananara. The largest reported concentration of Common Greenshanks in the area was over 200 individuals, at Lac Anony on 24 December (OL, LW, & SOC). On 10 November Bluntschli collected one near Amboasary-Sud (AMNH).

Actitis hypoleucos

Common Sandpiper

The Common Sandpiper is a migrant from Eurasia during the boreal winter. It was recorded in a variety of habitats: along the edge of the sea, shores of lagoons, and inland lakes, flooded grassy areas, and rice paddies from sea level to about 450 m. Records of this species in the region span the period from mid-October to late March. Generally single birds or pairs were observed. Occasionally, this species was found along river

margins in the spiny forest, e.g., one on 2 March along the eastern edge of parcel 3 of the RNI d'Andohahela and up to three individuals in mid-December along the Mandrare and Mananara rivers in parcel 2 of the same reserve.

Arenaria interpres

Ruddy Turnstone

The Ruddy Turnstone was relatively common along the seacoast, particularly in rocky areas (e.g., Manafiafy), between early October and late December. This migrant from Eurasia is a boreal winter visitor to Madagascar. It was generally observed singly or in groups of up to three individuals, although concentrations have been noted at Lac Anony on 20–21 September and 24 December. Presumably the nominate form is the one occurring in the southeastern region.

Gallinago macrodactyla

Madagascar Snipe

The Madagascar Snipe was rarely observed. Our records include displaying birds at Mandena over a small marsh in September and several individuals at the edge of the Analalava Forest in a damp grassland in early November. A specimen was collected at "Taolanaro, Tanosy" on 14 November (FMNH).

LOCAL NAME—*Arakarandroka* (Manombo).

Calidris alba

Sanderling

The Sanderling, a boreal winter migrant to Madagascar, was regularly observed along the seacoast between Manafiafy and Tolagnaro. The earliest record was a few at Lac Anony on 20–21 September. The largest recorded local concentration was a flock of over 50 birds on 25 December at Lac Andriambe. This species was rare along the Mandrare River near the RP de Berenty.

Calidris ferruginea

Curlew Sandpiper

The Curlew Sandpiper is a boreal winter migrant to the island. It was recorded on numerous occasions, particularly along coastal beaches, la-

goons, and lakes. The vast majority of our records fall between late September and late December, although there are reports from the austral winter months. Concentrations of this species are occasionally noted, for example about 100 individuals along the shore of Lac Anony in late December.

Stercorariidae

Catharacta antarctica Subantarctic Skua

An individual banded on Marion Island (46°55'S, 37°45'E) was recovered at Tolagnaro in March 1987 (Langrand, 1990).

Stercorarius longicaudus Long-tailed Skua

The only record of this species in southeastern Madagascar is a group of four birds observed off the coast of Tolagnaro on 22 December 1991 (Langrand & Sinclair, 1994).

Laridae

Larus dominicanus Kelp Gull

The Kelp Gull was regularly observed along the coast near Tolagnaro, north to Manafiafy and west to Lac Anony. Generally there was a preponderance of adults in the area. For example, on 24 December 1992 a flock of 36 individuals, all adults, was observed at Lac Anony. This gull occasionally flies up the Mandrare River as far as the RP de Berenty. There is no evidence of this species breeding in southeastern Madagascar, although it is present in varying numbers throughout the year.

LOCAL NAME—*Kolokoloky* (Berenty area).

Sternidae

Chlidonias hybridus [sclateri] Whiskered Tern

The Whiskered Tern was observed several times along inland lagoons between late September and late December. Flocks have been noted,

e.g., 35 on 25 December 1992 at Lac Andriambe. We found no evidence of this species breeding locally.

Sterna caspia Caspian Tern

The Caspian Tern was relatively uncommon. We observed this species along the seacoast near Manafiafy and Lac Anony in November and December. Generally single individuals or pairs were noted. This species also has been observed inland along the Mandrare River near the RP de Berenty (OL & LW).

Sterna hirundo Common Tern

On 22 August 1990, 23 Common Terns were observed off the coast of Tolagnaro (Langrand & Sinclair, 1994). This is the only record for this species in southeastern Madagascar.

Sterna dougallii Roseate Tern

The Roseate Tern was observed on several occasions off the coast of Manafiafy and Tolagnaro and near Lac Andriambe.

Sterna sandvicensis Sandwich Tern

Two Sandwich Terns were observed on 22 August 1990 off the coast of Tolagnaro (Langrand & Sinclair, 1994). This is the only known record of this species on Madagascar.

Sterna bergii Greater Crested Tern

Flocks of Greater Crested Terns were observed numerous times along the seacoast, generally between Manantenina and Tolagnaro and west to Lac Anony. In many cases the birds were a considerable distance offshore, and it was often difficult to determine if the flocks were composed of this species, the Lesser Crested Tern, and/or the

Roseate Tern. We found no evidence of any *Sterna* spp. breeding in southeastern Madagascar.

Sterna bengalensis Lesser Crested Tern

The Lesser Crested Tern was regularly observed off the coast, particularly in the region between Manafiafy and Tolagnaro. Flocks of up to 30–40 individuals were often noted foraging in the area of the sea where the waves started to break. The form occurring in the region is presumably *S. b. par*. This species seemed more common than the Greater Crested Tern, but in numerous cases crested terns far offshore could not be identified to species.

Columbiformes

Pteroclidae

Pterocles personatus Madagascar Sandgrouse

The Madagascar Sandgrouse is an inhabitant of open areas in the spiny forest. We know of no records from east of the western slopes of the Anosyenne Mountains; the eastern limit of this species appears to be near Mahamavo and Tanambao-Ankatsaky and slightly below the western limit of parcel 1 of the RNI d'Andohahela. This species was regularly observed near Hazofotsy and other areas within and near parcel 2 of this reserve. In the Ankapoky Forest flocks of two to six individuals were noted flying over in the early morning. Delacour's (1932, p. 33) statement that "Il existe probablement d'Analalava à Fort Dauphin" cannot be substantiated.

This species appears to have a preference for feeding in slightly degraded or open spiny forest or areas dominated by *Xerophyta* or introduced grasses around rocky ground. Flocks of up to 40 individuals often visit such sites on a daily basis in the late afternoon, e.g., the area near the Hazofotsy tombs. In early morning, particularly during the dry season, flocks of up to 100 individuals fly to the Mandrare and Mananara rivers to drink. In December this species was observed visiting and drinking from a tributary of the Mananara River throughout most of the day.

LOCAL NAME—*Hatrakatraka* or *hatrakatra* (Bealoka, Berenty, Hazofotsy).

Columbidae

Streptopelia picturata picturata Madagascar Turtle Dove

The Madagascar Turtle Dove was the most common columbid in the humid portion of the region from the Marovony Forest south along the coast and on the east side of the Anosyenne Mountains to Petriky. It occurs in intact and partially disturbed humid and littoral forests, heavily degraded forest, eucalyptus plantations, gardens, and agricultural fields from sea level to 1950 m. West of the Anosyenne Mountains, in transitional forest and spiny forest, it is the second most frequently encountered dove after *Oena capensis*. *Streptopelia* was common in gallery forest along the Mandrare River.

DIET—The stomachs of four individuals contained seeds. These birds feed predominantly on forest trails, paths, or dirt roads, from which they pick up seeds and grains. In humid forest they are usually seen walking around on forest litter. In November at the higher elevations of parcel 1 of the RNI d'Andohahela this species was often observed feeding on the seeds of *Sloanea*. One collected bird had 15 *Sloanea* seeds in its crop, all lacking the fleshy orange aril.

BREEDING—This species appears to have a relatively long breeding season. Active nests with eggs were found in the RP de Berenty on 3 July and 5 September (OL). In both cases the nests were less than 4 m off the ground and placed in a slender tree or in a thick bush. On 22 October in the Manafiafy Forest, an adult was attending a nest with one or two eggs. Adult males collected between mid-September and late December had testes up to 17 × 7 mm (left) and 12 × 5 mm (right), and adult females had ovaries up to 10 × 6 mm, enlarged oviducts, and ovarian follicles 7 mm in diameter. A female collected on 22 November in parcel 1 of the RNI d'Andohahela was in reproductive condition and had well-developed "milk glands" within the crop. A fledgling was netted at 1500 m on 21 November in parcel 1 of the RNI d'Andohahela.

WEIGHT—Female (6), 191.2 ± 12.3 (167–200) g; male (3), 190, 190, 192 g; combined (12), 190.8 ± 12.8 (165–210) g.

SOFT PART COLORS—Bill: generally gray at

base, distally pale bluish gray or light greenish gray, and gray tip, but in two adult males in breeding condition crimson at base; legs: dorsally dull pinkish red or purplish red and ventrally light red, greenish gray, or bluish gray; iris: brown, purplish red, or red; orbital ring: purplish red, crimson, dull red, or dark vermillion.

LOCAL NAMES—*Deho* (Berenty, Manafiafy, Marosohy), *kimokimo* (Manombo).

Oena capensis aliena

Namaqua Dove

The Namaqua Dove was common to abundant in areas of spiny forest; it was one of the more regularly netted species in the Ankapoky Forest. From the Anosyenne Mountains eastward this species was distinctly less common and generally confined to coastal areas. We noted it near Manantenina, Mandena, Tolagnaro, and Petriky. There are few inland records from the humid forest zone. This species has been observed near Isaka-Ivondro on several occasions, mostly during the dry season. Bluntschli collected three Namaqua Doves near Eminiminy between 15 October and 1 November (AMNH, SMF). The elevational range of this species is from near sea level to 100 m.

DIET—This species utilizes sand or dirt roads, trails, and paths in open areas to search for food and is not found in closed canopy or dense forest habitat. It feeds primarily on seeds.

BREEDING—Several males netted at Ankapoky in mid-October had testes up to 12×19 mm, and females had large ovaries and ovarian follicles up to 20 mm.

WEIGHT—Female (3), 35, 36, 38 g; male (5), 38.4 ± 2.5 (36–42) g; combined (10), 37.9 ± 2.51 (36–42) g.

SOFT PART COLORS—Bill: maroon at base, orange in middle, and dull yellow or light orange tip (males) and dull reddish brown or brownish black (females); legs: maroon, gray, or pinkish red; claws: gray or black; iris: brown.

LOCAL NAMES—*Tsikaloto* (Berenty).

Treron australis australis

Madagascar Green Pigeon

The Madagascar Green Pigeon was a relatively common inhabitant of intact and degraded humid and littoral forests from the Marovony Forest south along the coastal plain and through the An-

osyenne and Vohimena mountains to Tolagnaro, from sea level to about 1000 m. On a few occasions flocks of up to 20 individuals were seen flying around gardens in Tolagnaro, presumably exploiting ripening fruits. It was uncommon in spiny forest, where it may be only a seasonal visitor. One was taken by Bluntschli on 17 November at Amboasary-Sud (AMNH). In 7 weeks of field work between October and November in parcel 1 of the RNI d'Andohahela, this species was only noted once (at 440 m), which suggests that at this season fruits eaten by this species were not common in this humid forest sector or that in this region it does not occupy extensive areas of closed-canopy forest.

DIET—A large component of this species' diet appears to be *Ficus* fruits, and its movements may be related to local availability of this resource. One Madagascar Green Pigeon collected from a flock of 12 feeding in a *Ficus* tree at Manafiafy had 65 fruits in the crop that in total weighed 41 g. At Itapera this species was observed feeding on *Abrus* fruits. In the Marovony Forest three individuals were observed with two *Alectroenas madagascariensis* consuming *Uapaca* fruits. At Lanirano it was often noted eating mulberry (*Morus*) fruits. In the RP de Berenty it was seen feeding on the ripe and unripe small fruits of *Ficus grevei* and *Phyllanthus seyrigii*.

BREEDING—A female taken on 24 October at Manafiafy had a slightly enlarged ovary, thickened oviduct, and ovarian follicles up to 6 mm in diameter.

WEIGHT—Combined (2), 215, 215 g.

SOFT PART COLORS—Bill: vermillion at base with horn-color tip or crimson at base with cold gray tip; legs: dull orange or orangish yellow; claws: black; iris: cobalt blue or bluish white.

LOCAL NAMES—*Bohaky* (Manafiafy, Marosohy), *fonomavo* (Manombo).

Alectroenas madagascariensis

Madagascar Blue Pigeon

The Madagascar Blue Pigeon was noted in a variety of habitats from intact to heavily disturbed humid and littoral forest from Marovony south through the Vohimena and Anosyenne mountains to just north of Tolagnaro at elevations from near sea level to 1950 m. The locality of a specimen taken in 1756 was listed as Fort-Dauphin (Stressmann, 1952). One was collected at Eminiminy on 27 October by Bluntschli (SMF). This species

will often sit in the top of canopy trees, particularly emergents with dead wood, to vocalize.

DIET—The stomach of an individual taken 7 km north of Tolagnaro on 8 May contained seeds of an unidentified plant locally called *rithala* (MNHN). In the littoral forest of Manafiafy this species was observed feeding on fruits in a *Ficus* alongside *Hypsipetes* and *Coracopsis nigra*. In early November *Alectroenas*, *Treron*, and *Eulemur fulvus* were regularly observed feeding on fruiting *Uapaca* trees in the Marovony Forest.

BREEDING—The specimen collected by Bluntschli had small testes. In parcel 1 of the RNI d'Andohahela this species was noted nest building at 1200 m on 12 November and at 1500 m on 23 November. The nest consists of a shallow platform of twigs placed about 3 m off the ground in small shrubs. Both adults participated in nest construction and flew 10–200 m away from the site to collect sticks. On returning to the nest site, the adults regularly gave a low, muted cooing call.

SOFT PART COLORS—Bill: dark green; legs: black; iris: red.

LOCAL NAMES—*Foli manga* (Manafiafy), *foly manga* (Marosohy), *fonomity* (Manombo).

forest of parcel 2 of the RNI d'Andohahela, *C. vasa* was about equally common as *C. nigra*.

A specimen collected in the Bemangidy Forest on 26 December is referable to *C. v. vasa* (FMNH). This is presumably the form occurring from the Marovony Forest south through the Anosyenne and Vohimena mountains. West of the Anosyenne, in the spiny forest, *C. v. drouhardi* is the expected subspecies.

DIET—In an open area at the edge of the Marovony Forest three Greater Vasa Parrots were observed feeding in a *Ficus* tree. In gallery forest this parrot often feeds on *Tamarindus* fruits. A flock of at least 10 birds was observed in Bealoka on the forest floor feeding on fallen pods. It also was observed in the same region consuming the fruits and seeds of *Ficus megapoda*, *Celtis gomphophyla*, *C. philippensis*, *Quivianthe papinae*, and *Neotina isoneura* and the leaves of *Acacia*.

BREEDING—Displaying *C. vasa* in parcel 2 of the RNI d'Andohahela in December showed bare orange skin on their heads. It is not clear if the lack of feathering is caused by the mechanical or hormonal aspects of courtship—the male grasps hold of the head of the female and jerks it up and down in display, which might cause head feathers to be lost. However, apparent male birds were seen with this feature, suggesting that it is not only caused by mechanical methods. Information on the breeding display and copulation behavior of both Malagasy *Coracopsis* in captivity have been reviewed by Wilkinson (1990) and Wilkinson and Birkhead (1995).

LOCAL NAMES—*Kia* (Marosohy); *vazambe* (Bealoka, Berenty); *boeza*, generic for *Coracopsis* spp. (Manombo).

Psittaciformes

Psittacidae

Coracopsis vasa vasa and [*Coracopsis vasa drouhardi*]

Greater Vasa Parrot

The Greater Vasa Parrot was generally uncommon. It was observed in intact and degraded humid forests and in agricultural areas on lateritic soils, e.g., in or at the edge of the Marovony, Analamava, Bemangidy, and Marosohy forests. It was relatively common in spiny forest and in sisal plantations. This species' elevational range is from near sea level to 1950 m. Previously this species was thought to occur only to about 1000 m (Langrand, 1990). There is no documented record of it in littoral forest. This species was less common than but broadly sympatric with *C. nigra*. Flocks of *C. vasa* are seldom larger than three or four individuals. Between October and December in parcel 2 of the RNI d'Andohahela, point count contact frequency of *C. vasa* was only 20% of the frequency of *C. nigra*. In the spiny

Coracopsis nigra nigra and [*Coracopsis nigra libi*]

Lesser Vasa Parrot

The Lesser Vasa Parrot was relatively common throughout the region, including in intact and degraded humid, littoral, gallery, and spiny forest, agricultural areas, sisal plantations, and gardens in villages. It was recorded from sea level to 1800 m. Flocks of 10 individuals were not uncommon, and one group of 19 birds was noted at the edge of the Marovony Forest. This species is locally considered an agricultural pest, particularly with ripening corn and rice crops, and is consequently persecuted by local people. It is generally far more numerous and vocal than *C. vasa* (Table 2).

Specimens from Manafiafy and Eminiminy are referable to *C. n. nigra*, which is presumably the form occurring in the Anosyenne and Vohimena mountains east to the coast, whereas the populations west of the Anosyenne Mountains in spiny forest may be *libs*.

DIET—The stomach of a specimen taken 7 km north of Tolagnaro on 19 February (MNHN) contained ripe fruits of a plant locally known as *ro-hala*. In the Marosohy Forest at about 900 m a flock of six Lesser Vasa Parrots was feeding on the fruits of a *Macaranga*. This parrot species also has been observed feeding on *Sarcolaena multiflora*, almost open buds of *Sympomia* and *Humbertia madagascariensis*, the blue pericarps of *Ravenala madagascariensis*, and the seeds or fruits of *Tamarindus*, *Alluaudia procera*, *Agava rigida*, *Celtis philippensis*, *Hippocratea rubignosa*, *Acacia farnessiana*, *Croton*, *Ficus*, *Melia azedarach*, *Uapaca*, and *Neotina isoneura*.

BREEDING—An adult male taken on 23 October had small testes. The specimen from 7 km north of Tolagnaro had a slightly enlarged ovary.

WEIGHT—Combined (2), 215, 220 g.

SOFT PART COLORS—Bill: brownish horn; legs: dark brown or bluish gray; claws: gray or black; iris: dark brown.

LOCAL NAMES—*Boloky* (Manafiafy), *kia* (Marosohy), *vaza* (Manafiafy), *vazatsihotsy* (Berenty).

Agapornis cana cana and *Agapornis cana ablactanea*

Gray-headed Lovebird

The Gray-headed Lovebird was relatively common in spiny forest and distinctly less common in agricultural and grassland areas near and in humid forest from sea level to 325 m. In the spiny bush it can often be seen in sisal plantations and perched on dead trees or *Alluaudia procera*. This species was distinctly uncommon in littoral forest, e.g., Mandena and Itapera. There is a specimen collected in 1756 near Fort-Dauphin (Stresemann, 1952). It was often noted in flocks ranging in size from 3 to 20 individuals. The nominate subspecies is found from the Marovony area south through the Vohimena Mountains, at least to the eastern slopes of the Anosyenne Mountains and presumably south toward the coastal forest, and *ablactanea* is found from the western side of the Anosyenne Mountains to the Mandrare River. A specimen taken by Milon 30 km NNW Fort-Dauphin is referable to *A. c. cana* (MNHN), whereas

TABLE 2. Observations of *Coracopsis vasa* and *C. nigra* on morning transects in the Malaza Forest from May 1984 to April 1985, based on 7.3 km of trail surveyed per month.

Month	Total observed	
	<i>C. vasa</i>	<i>C. nigra</i>
1984		
May	3	6
June	7	0
July	2	8
August	0	11
September	5	14
October	0	7
November	3	8
December	0	7
1985		
January	0	20
February	2	26
March	2	12
April	2	13

specimens collected at Ankapoky are referable to *A. c. ablactanea* (FMNH).

DIET—The crop and stomach of the Milon specimen contained many grass seeds. This species visits the heads of sisal flower stalks and will also descend to ground to feed on fallen seeds. Foraging flocks are often more active in the morning than in the afternoon and consist disproportionately of males (Table 3).

BREEDING—All four adults taken in mid-October in the Ankapoky Forest had small reproductive organs; one immature with a bursa also was collected. The Milon specimen taken on 26 May had testes 4.5×2.2 mm. On 1 March, in the RP de Berenty, a female was observed in gallery forest entering a hole in a tree about 5 m off the ground (OL); nesting sites include holes in dead *Tamarindus*, *Acacia*, *Neotina*, *Alluaudia*, and *Quivisanthe* trees. Nesting apparently commences in April or May. Chicks fledge and sites are vacated before the arrival of *Eurystomus glaucurus* in October, which also occupies the same holes. If a site is not used by *Eurystomus*, then lovebirds will occupy and visit holes during portions of the nonbreeding season. The timing of this parrot's breeding season may be an adaptation to avoid competition for nesting sites with the larger and more aggressive *Eurystomus*.

WEIGHT—Combined (5), 29.8 ± 1.9 (27.0–31.5) g.

SOFT PART COLORS—Bill: flesh gray or cold

TABLE 3. Observations of *Agapornis cana* on morning and evening transects conducted in the RP de Berenty May–September (14.6 km of trail per month) and October–April (7.3 km of trail per month).

Month	Number of birds (am/pm)	Largest flock	Sex ratio (♂:♀)	Trees visited ¹	Number of trees used as perches	% trees dead	% trees <i>Tamarindus</i>	% trees <i>Acacia</i>
1984								
May	30/4	15	27.5	At, Ab, K, Qu, K	16	25	13	38
June	53/16	10	8.3	At, K	7	43	29	29
July	69/26	9	29.7	Al, At, Co, Cr, K, Qu, S	13	54	23	15
August	72/—	9	25.7	At, K, S	6	50	17	50
September	58/2	8	3.1	At, K	1	100	—	—
October	48	9	2.0	At, K	3	33	33	33
November	30	4	4.1	Ap, At, K, Qu	8	13	63	13
December	15	7	2.0	Al, At	2	—	—	50
1985								
January	37	10	4.2	At, K	4	50	25	25
February	49	11	7.5	K	1	—	100	—
March	26	11	1.1	At	2	50	—	50
April	4	4	—	—	—	—	—	—
Average	—	8.9	♂ = 71.4%	—	—	36.5	25.4	28.6

¹ Ab = *Acacia farnessiana*, Al = *Alluaudia procera*, Ap = *Albizia polypylla*, At = *Acacia rovumae*, Co = *Croton*, Cr = *Crataeva excelsa*, K = *Tamarindus indica*, N = *Neotina isoneura*, Qu = *Quivisianthe papiniae*, S = *Agava rigida*.

grayish white; legs: gray or bluish gray; claws: black; iris: brown.

LOCAL NAMES—*Farivaza* (Berenty), *kariaka* (Berenty, Marosohy), *kariaky* (Manafiafy), *kitreoky* (Manombo), *sarivazy* (Manafiafy).

Cuculiformes

Cuculidae

Cuculus rochii

Madagascar Lesser Cuckoo

The Madagascar Lesser Cuckoo migrates to East Africa during the austral winter (May–August). When this species arrives in southeastern Madagascar it is practically ubiquitous. We noted it calling for hours at a time, often at night, from high perches in or at the edge of humid, gallery, and spiny forest throughout the region from near sea level to approximately 1950 m. The only littoral forest site at which we recorded it was Itapera. Because all of the field work at littoral forest sites was during the cuckoo's highly vocal period in Madagascar, our failure to find this species there indicates that it was absent or rare in these

forests. The species of birds this cuckoo regularly parasitizes, e.g., *Terpsiphone mutata* and *Neomixis tenella* (Langrand, 1990), are common in littoral forest. *Cuculus* was present in humid forest of parcel 1 of the RNI d'Andohahela from 440 m to 1950 m, although it was rare above 1500 m.

Apart from the well-known "tao-tao-kafo" call of the male, there is also an infrequently heard call, consisting of a loud series of single notes, "pee-pee-pee-pee-pee-pee-pee," that is similar in tone structure and frequency to calls made exclusively by females in other *Cuculus* spp. When this call was replayed in the presence of singing males, they typically stopped calling almost immediately and then flew toward the source of call. They then started singing again.

LOCAL NAME—*Taotaokafo* (Berenty, Manombo, Marosohy).

Coua gigas

Giant Coua

The Giant Coua was a relatively common inhabitant of spiny forest and gallery forest, including the transitional forest of parcel 3 of the RNI d'Andohahela and the littoral forest as far north as Manafiafy. This species was regularly heard

and seen in the degraded Mandena Forest but was not recorded in the Bezavona Forest, with lateritic soils, a few kilometers away. In mid-October the Giant Coua was one of the most frequently heard birds in the Itapera Forest. Here, as in the remaining littoral forest fragments of Manafiafy and Mandena, this species was often found in parcels of forest less than a few hectares in size and was observed walking about in heavily disturbed areas between forest patches. Thus, it appears that this species is tolerant of considerable forest degradation and is able to move between forest fragments. In the RP de Berenty the densest populations occur in the tall closed-canopy gallery forest, where the leaf litter is thickest. This species was common in spiny forest adjacent to gallery forest along the Mananara River in parcel 2 of the RNI d'Andohahela. Bluntschli collected one specimen near Amboasary-Sud on 22 October 1931 (SMF); at this time extensive gallery forest remained along the banks of the Mandrare River.

On 17 December in the Malaza Forest a "large boa (*Acantophis dumerili*) [was] seen striking, constricting and killing [a] . . . *Coua gigas*; [an adjacent] bird went berserk, calling and flapping its wings from a perch 2-3 feet above the scene. Death was slow and the [bird] . . . continued flapping . . . [its] wings for minutes after the strike" (SOC).

Given its terrestrial habits, *C. gigas* is probably easy for local people to capture. Indeed, at most sites where this species was recorded there was direct or indirect evidence that it is hunted for food by local people. Hunting techniques included slingshots, snares, and walk-in traps. A local villager at Ankapoky mentioned that his sons were able to capture at least one Giant Coua every 2 weeks and that this meat was an important supplement to the family's diet. At Bealoka in early 1984, one or two pairs were present, but by 1987 this species was absent. Its disappearance is presumably related to hunting.

DIET—The stomachs of two collected birds contained *Diplopoda*, beetles (Carabidae, Curculionidae, Scarabaeidae, Tenebrionidae), ants (Formicidae), flies (Asilidae), lepidopteran larva, and small seeds (Goodman & Parrillo, in press). The stomach of a specimen collected at Mandena on 28 July contained remains of grasshoppers and various other insects (MNHN).

Foraging often involves chasing down insect or small reptilian prey. Giant Couas react and run very quickly. A coua in pursuit of prey may change directions at very acute angles, often

pushing off trees or other vertical surfaces with the feet and legs. It has been observed leaping a meter or so into the air from the ground to catch prey in flight. This species also scrapes in leaf litter in search of food.

BREEDING—Nests of this species found in the RP de Berenty were built by both males and females. If birds are discovered during nest building they will wait long periods before returning to the nest or take alternative routes to keep the location secret. The nests are relatively elaborate structures composed of large twigs or small branches in *Acacia* or *Tamarindus* trees and usually in vines and lianas in areas of dense vegetation. In the RP de Berenty nest building has been observed between late October and late December, and chicks have been seen in January. Two males collected at Petriky in late September had testes 10×8 mm and 10×5 mm.

WEIGHT—Combined (2), 410, 415 g.

SOFT PART COLORS—Bill and legs: black; iris: deep reddish brown; orbital ring: above eye bright greenish blue, below and posterior to eye purplish, and anterior to eye grayish blue.

LOCAL NAMES—*Eoka* and *aoka* (Berenty).

Coua reynaudii

Red-fronted Coua

The Red-fronted Coua was widespread in the humid forests of the region from the Marovony Forest south through the Anosyenne and Vohimena mountains to the Manantantely Forest, between 50 and about 1950 m. This species was relatively common in the forests of Marovony, Analalava, Bemangidy, Marosohy, Bezavona, and Manantantely. In parcel 1 of the RNI d'Andohahela it was much less frequently recorded on point counts at 440 m and 810 m than at 1200, 1500, and 1800 m. It was not recorded at any littoral forest site.

On 26 December 1992 feathers of at least two adult Red-fronted Couas were found on the ground under a rock overhang along the Isedro Trail in parcel 1 of the RNI d'Andohahela at about 425 m. Also, in early October 1995 feathers of this species were found along the Tanatana Trail between Isaka-Ivondro and Eminiminy. These birds probably were killed by hunters, most likely with a slingshot.

DIET—The stomach of an individual collected in the Marovony Forest contained Araneae, various types of Coleoptera (Cerambycidae, Curcu-

lionidae, Elateridae, Scarabaeidae), Orthoptera (Euschmidtiidae, Tetrigidae), and Phasmatodea (Goodman & Parrillo, in press). This species will use forest clearings and edge habitat along trails or roads to search for food among dense vine tangles.

BREEDING—In parcel 1 of the RNI d'Andohahela a presumed female was building a nest at 1200 m on 16 November. It picked up dead ferns, bits of liana, and roots for construction material. The presumed male accompanied the female for a few minutes while the female looked for nesting material. The bird then captured a 3-cm-long caterpillar and offered it to the female. They attempted to mate, and the male departed while the female continued with nest construction. The nest was a wide shallow cup built in a tangle of vegetation at the end of a fallen tree about 2 m off the ground.

WEIGHT—Sex unknown (1), 163 g.

SOFT PART COLORS—Bill: black; legs: slate colored; claws: black; iris: brown; orbital ring: posterior to eye bright sky blue, and anterior to eye cobalt blue.

LOCAL NAMES—*Pokafo* (Marosohy and parcel 1, RNI d'Andohahela), *taitoaky* (Marovony).

Coua cursor

Running Coua

The Running Coua was an inhabitant of the spiny forest. The eastern limit of its range appears to be the lower western slopes of the Anosyenne Mountains. It was recorded at the edge of the transitional forest, near Mahamavo, just below the Col d'Ambatomanaha on the west side of parcel 1 of the RNI d'Andohahela. This species occurs in spiny forests but not in gallery forest. It was fairly common in spiny forest near the Mananara River in parcel 2 of the RNI d'Andohahela, although it was the least frequently recorded of the four *Coua* species present at this site.

DIET—One bird from Ankapoky had spiders (Araneae), beetles (Curculionidae), cicadas (Cicadidae), ants (Formicidae), and plant material in its stomach (Goodman & Parrillo, in press).

BREEDING—A female collected at Ankapoky on 9 October had an enlarged ovary with follicles up to 10 mm.

WEIGHT—Female (1), 118 g.

SOFT PART COLORS—Bill, legs, and claws: black; iris: brown; orbital ring: deep blue with purple tint.

LOCAL NAME—*Aliotsy* (Berenty).

Coua ruficeps olivaceiceps

Red-capped Coua

The Red-capped Coua was relatively common in the spiny forest region, including parcels 2 and 3 of the RNI d'Andohahela south to at least the Bevilany and Fotsivolo hills. Langrand (1990) noted that it occurs as far south as Lac Anony. Milon collected an adult female, referable to *C. r. olivaceiceps*, near Ranopiso on 31 May (MNHN). In December 1995 this species was the most common *Coua* in the spiny forest along the Mananara River in parcel 2 of the RNI d'Andohahela.

DIET—The stomach of the Ranopiso specimen contained insects and numerous seeds.

BREEDING—This Ranopiso specimen had an ovary 9 × 4.5 mm with no enlarged egg follicles. In December east of Hazofotsy, a juvenile was entering postjuvenile molt.

LOCAL NAME—*Aliotsy* (Berenty).

Coua cristata maxima and *Coua cristata pyropyga*

Crested Coua

The Crested Coua was an inhabitant of the spiny forest region. Its current eastern limit appears to be the lower western slopes of the Anosyenne Mountains, where it was recorded near Mahamavo, Eavia, and Tanambao-Ankatsaky, east along the coast as far as the Petriky Forest, and south to the Andraraky Hills due east of Mokobe. Throughout this region it was relatively common and is represented by the subspecies *C. c. pyropyga*.

In 1950 Milon described a new subspecies of Crested Coua, *C. c. maxima*, from the environs of Fort-Dauphin (= Tolagnaro). Stresemann (1952) suggested that the type specimen of *C. cristata* also came from the Tolagnaro area (but see below). The holotype of *maxima*, the only known specimen of this form, is distinctly larger than *C. c. pyropyga*, with no overlap between these forms in four external measurements (Table 4). Further, *maxima* differs from typical *pyropyga* in plumage coloration. The following comparisons are based on the holotype of *C. c. maxima* (MNHN 1950.392) and a series of *C. c. pyropyga* from several localities in the southwest (MNHN): the upper tail surface of *maxima* is an intense violet blue (rem-

TABLE 4. External measurements (in mm) of *Coua cristata maxima* and *Coua cristata pyropyga*, based on Milon (1950).

Measurement	<i>maxima</i> (N = 1)	<i>pyropyga</i> (N = 14) ¹
Wing	175	162 (157–168)
Tail	232.5	212 (208–224)
Tarsus	45	41.2 (38.5–43.5)
Bill (from commissure)	30	26.7 (25–28.5)

¹ Mean (range).

iniscent of *C. caerulea*) as compared with the more subdued iridescent blue with a greenish tinge in *pyropyga*; the innermost secondaries of *maxima* are distinctly blue, whereas in *pyropyga* they are iridescent green; the back of *maxima* is a grayish blue and that of *pyropyga* is gray or greenish gray; in *pyropyga* the lower breast is white with a rufous vent and in *maxima* it is tawny brown with no clear sign of a change in coloration at the vent (although the specimen apparently lost most of the undertail coverts during preparation); and in *pyropyga* the white belly merges anteriorly from a light tawny brown lower mid-breast to a purplish gray mid-breast and lower throat and ends in a gray throat, whereas in *maxima* the tawny brown lower breast merges to a darker tawny brown upper breast and cold bluish gray throat. Milon (1950) noted that the ventrum of the *maxima* specimen was tawny cinnamon with no reddish coloration at the base of the tail.

We failed to find anything resembling *maxima* in any area in which we worked in southeastern Madagascar. Most of the natural lowland forest in the immediate vicinity of Tolagnaro has been destroyed. One of the last vestiges of somewhat intact habitat was near Lac Lanirano, 2 km north of Tolagnaro, where one *C. cristata* was observed and heard calling in August 1988; by 1989 this individual apparently had disappeared. A search for this species in the small remnant forest of Lac Lanirano in late December 1992 was unsuccessful. No particular note was made at the time of plumage characters of the bird observed at Lac Lanirano in 1988, and it is not known whether this bird was *maxima*. This possibility may be unlikely, because Milon (1950) noted that in life the type of *maxima* was easily confused at first view with *C. caerulea*.

Stresemann (1952) reported that the holotype of *Coua cristata* was collected in 1752 by Poivre in

the Fort-Dauphin area; nothing remains of these collections. The Poivre specimen, "Coucou hupé de Madagascar," was the holotype of *Cuculus cristatus* L. 1776 and was illustrated by Daubenton (1770–1786, plate 589). Although somewhat stylized, this color plate clearly shows a bird with rufous coloration in the undertail coverts and a white lower ventrum. Further, Brisson's (1760, p. 150) description of the specimen notes that it has a white underside and that the feathers at the base of the tail are reddish white (our translation). Thus, on the basis of these characters the Poivre specimen is not referable to *C. c. maxima*. Further, the Poivre specimen had a reddish venter, which opens up the taxonomic problem that the holotype of nominate *cristata*, which is distinguished in part from *C. c. pyropyga* by its tawny undertail coverts (Delacour, 1931), probably represents the population now known as *pyropyga*.

The taxonomic status of *maxima* is unclear. At this stage it could be a geographic form of *C. cristata*, a distinct species, or even a hybrid between *C. cristata* and one of the two other couas living in the region (i.e., *C. caerulea* and *C. reynaudi*). Current research on the intrageneric relationships of the couas might help to resolve this question.

The southern limit of *C. c. cristata* in eastern Madagascar appears to be in the vicinity of RS de Manombo, south of Farafangana (Nicoll & Langrand, 1989). This locality is approximately 130 km north of the Marovony Forest. Thus, this species is absent from the humid and littoral forests (excluding Petriky) of southeastern Madagascar.

The calls of *C. cristata* are loud and carry for long distances. Often the calls of one bird will initiate responses from others, especially at dawn and dusk. Such a bout of countercalling may continue quite far through a gallery forest as 15 or more birds respond to one another.

DIET—*Coua cristata* gleans prey from trunks and branches of large mature trees of *Albizia polystyphilla* and *Acacia rovumae*. Starting at the base of the tree it progresses systematically up the trunk while rapidly checking nooks and crannies and under leaves. At the top of the tree it then glides to the base of the next tree, starting the process over again. It often walks or hops up along nonvertical tree trunks and branches, and invariably the process includes short bursts of flying and gliding.

Specimens collected near Petriky had Coleoptera (Curculionidae), Hemiptera, Homoptera, lepidopteran larvae, Mantodea, orthopterans (Acrid-

idae, Euschmidtidae, Grylidae, Pyrgomorphidae), Phasmatodea (Phylliidae), and plant seeds in their stomachs (Goodman & Parrillo, in press). Birds have been seen carrying lizards (*Mabuya*), geckos, chameleons, locusts, and beetles in their bills. *C. cristata* is often observed in *Albizia polypylla* trees searching for prey. This tree also exudes copious quantities of resin that this coua feeds on. In spiny forest this species had been previously reported to feed on sap (Charles-Dominique, 1976). In the humid forest of Manombo we saw it feeding on sap. It also has been observed eating tree flower buds in the RP de Berenty (OL & LW).

BREEDING—In the RP de Berenty young fledglings have been observed from late October to early February. Fledglings beg by fluttering their wings while uttering a humming-hissing vocalization. Several nests were found at the RP de Berenty in the understory of *Celtis philippensis* trees. Three adult males taken at Petriky in late September had testes ranging in size from 4 × 2 mm to 10 × 4 mm. A female collected at Ankapoky on 11 October had a vascularized brood patch, a shelled egg in the oviduct, ovarian follicles 26 and 16 mm, and no corpus luteum. On 15 November in the Hazofotsy Forest an adult was observed feeding a fledgling capable of flight, and on 8 December at a nearby site a juvenile was being attended by two adults. Nests have been found in January near Hazofotsy in a *Moringa* tree.

WEIGHT—Combined (6), 144.2 ± 7.5 (135–152) g.

SOFT PART COLORS—All *pyropyga*. Bill and legs: black; iris: red, bright purplish blue, or reddish brown; orbital ring: posterior to eye mixed sky blue or greenish blue and brilliant green and anterior to eye cobalt blue, bright purplish blue, or purplish brown.

LOCAL NAMES—*Fandikalala* (Manombo), *tivoka* (Berenty).

Coua verreauxi Verreaux's Coua

This species has been reported from the RP de Berenty (Langrand, 1990). The juvenile plumage of *C. cristata* can be easily confused with that of *C. verreauxi*, and we suspect that records of *C. verreauxi* from this locality are in error. Until further documentation is available this species is not considered to occur in southeastern Madagascar.]

Coua caerulea

Blue Coua

The Blue Coua was the most common of the humid forest couas. It was recorded from the Marovony Forest south through the Anosyenne and Vohimena mountains to Manantantely and Pic St. Louis from near sea level to 1800 m. In parcel 1 of the RNI d'Andohahela this species was observed between 440 and 1800 m but was recorded most commonly on point counts at 440, 810, and 1200 m and was much more scarce at 1500 and 1800 m. During the 1989 and 1990 field seasons, this species was relatively common in the littoral forests of Manafay and Itapera but was absent from Mandena. At Mandena one individual was observed in May 1988, and presumably it was locally uncommon or perhaps moved seasonally between the littoral forest and nearby humid forest on lateritic soils. There are several older records from the Tolagnaro area (Lavauden, 1937; Milon, 1952), including a specimen taken in 1756 near Fort-Dauphin (Stresemann, 1952). This species still occurs at Pic St. Louis, 3 km from Tolagnaro. The Blue Coua was not recorded in the remaining coastal forest patches west of Tolagnaro (e.g., Petriky) or in the spiny forest region. Severe hunting pressure combined with habitat destruction over the past few decades, particularly in forests near villages, may have greatly altered the distribution of this species.

Nowhere in southeastern Madagascar is the Blue Coua sympatric with the Crested Coua, and in this region these two species of arboreal couas appear to replace one another geographically. In the humid forest below the Col d'Ambatomanaha, on the western side of parcel 1 of the RNI d'Andohahela, the Blue Coua was relatively common. At about 810 m, when the abrupt transition to dry forest commences, this species dropped out, and by 650 m the Crested Coua was common. This change is over a ground distance of less than 2 km. To the north, as in the RS de Manombo (130 km north of the Marovony Forest), these two species are sympatric in humid forest.

DIET—On several occasions we observed the Blue Coua in littoral forest feeding on a resin-like substance exuded from the ripe fruits and trunk of *Sloanea rhodantha*. The stomachs and lower intestines of two individuals taken at Manafay and of one taken at Marovony contained a sticky, viscous, and non-water-soluble liquid. Stomach contents of individuals collected in the general Tolagnaro area (FMNH, MNHN) included various

types of insects (often grasshoppers) and a large millipede 90×7 mm. One bird taken in littoral forest had a centipede (Scolopendromorpha) and a Phasmatodea in its stomach (Goodman & Parillo, in press). On several occasions we observed this species feeding on insects either on the ground or at various levels in the forest understory.

In humid forest at 1500 m in the RNI d'Andohahela, an adult was observed holding a *Calumma nasutus* chameleon and a large katydid in its bill, which were fed to a second Blue Coua; this was probably an example of courtship feeding. In the Bezavona Forest a Blue Coua was noted feeding on the unopen flower buds of *Sympodia*.

On several occasions we observed *C. caerulea* following within a few meters behind troops (four to over 15 individuals) of the Brown Lemur (*Eulemur fulvus*). This association was noted in both littoral and lowland humid forests and always involved a single bird. *E. fulvus* generally moves in the lower to middle portion of the forest and is largely folivorous and frugivorous (Richard & Dewar, 1991); this species also has been recorded eating invertebrates (spiders, millipedes, cicadas) and fungi and, at least in captivity, vertebrates (Glander et al., 1985; O'Connor, 1987). Although no prey was caught by the Blue Couas that we observed following troops, it is likely that the movements of the lemurs would scare or expose prey upon which the bird may feed.

BREEDING—There was variation in the breeding condition of Blue Couas obtained at Manafiafy in October. A male in adult plumage had testes 3×1 mm, whereas the testes of two other adult males were (left and right, respectively) 12×5 mm and 9×4 mm, and 15×6 mm and 10×5 mm. An adult female taken during the same period had ovarian follicles 16×14 mm, 11×11 mm, and 4×4 mm and had one ruptured follicle. A male collected at Marovony on 2 November had testes 13×9 mm (left) and 12×7 mm (right).

Milon collected two specimens on 28 May 30 km NNW Tolagnaro: a female with a slightly enlarged ovary and an ovarian follicle of 9 mm and a male with testes 3.5×1 mm (left) and 4×1 mm (right) (MNHN). A female taken 7 km north of Tolagnaro had a nonenlarged ovary (MNHN).

On 15 October in the littoral forest of Manafiafy a Blue Coua was heard giving a "purr-like" call from a 1.5-m-high perch. The coua held a frog (*Heterixalus boettgeri*) in its bill. The frog was positioned in the bird's beak so that its bright

yellowish orange legs and ventrum were conspicuously exposed. The coua gave a "purr-call" as it slowly lowered and raised its head every 2–3 seconds. This sequence was repeated numerous times. After every two or three such sequences the bird would flick the wings open to a one-quarter to one-half position, immediately close them, and then lift the tail, open it into a fan-like position, and then close it. After about 10 minutes of repeating this display another Blue Coua called from about 40 m away. At this point the intensity of the display increased at least twofold, and the displaying bird completely opened the wings and fanned the tail with each bow. After the second bird flew off, the intensity and frequency of the display returned to the original level. The bird then was disturbed by someone passing by in the forest and flew off.

WEIGHT—Combined (6), 235.3 ± 11.7 (225–257) g.

SOFT PART COLORS—Bill, legs, and claws: black; iris: brown or reddish brown; orbital ring: anterior to eye purplish blue and posterior to eye cobalt blue or in general orbital ring cobalt blue or violet blue.

LOCAL NAMES—*Teso* (parcel 1 of the RNI d'Andohahela), *tetso* (Manombo, Marosohy), *tetso manga* (Manafiafy), *tivoka* (Manafiafy).

Centropus toulou toulou Madagascar Coucal

The Madagascar Coucal inhabits a variety of habitats. It was most common in thick secondary scrub and other types of dense vegetation, although it can be found in relatively intact littoral, humid, spiny, and gallery forests. It also occurs in *Phragmites communis* marshes, thick grasslands, vegetated fence rows at the edge of villages and gardens, and eucalyptus and sisal plantations. Its elevational range in the region was from near sea level to about 1700 m. In the RNI d'Andohahela (parcel 1) this species was relatively scarce and was recorded at 440, 1200, and 1500 m in intact humid forest and at 1700 m in transitional forest north of Trafonaomby.

Female *C. toulou* are significantly larger than males (Andersson, 1995; our weight data below), as is the case for a number of other species in this genus (Andersson, 1995). An African species of *Centropus*, *C. grillii*, which is thought to be closely related to *C. toulou* (Snow, 1978), is polyandrous (Vernon, 1971), as might be expected from

a species that shows reversed size dimorphism between the sexes (Andersson, 1995). The mating system of *C. toulou* is not known but is worthy of study. We strongly suspect that polyandry will be demonstrated in this species as well.

DIET—The stomach of a specimen taken near Mandena (MNHN) contained debris of spiders and grasshoppers. Birds collected in littoral forest areas had a wide assortment of remains in their gizzards, including centipedes (Scolopendromorpha), spiders (Araneae, Salticidae), cockroaches (Blattodea), beetles (Elateridae, Scarabaeidae, Tenebrionidae, Tettigoniidae), ants (Formicidae), crickets (Gryllacrididae), mantids (Mantidae), and a small gecko (Goodman & Parrillo, in press). Adults were observed on 12 December carrying a large grasshopper and a smaller cricket to a nest placed in riverside vegetation along the Mananara River.

BREEDING—Four specimens taken near Manafiafy in the second half of October were in or approaching breeding condition. These included two males (both with degenerated left testes); one had a 6-mm bursa and the right testicle was 12 × 9 mm, and the other had no bursa and the right testicle was 15 × 7 mm. Rand (1933) also noted testicular asymmetry in this species. A female taken on 16 October had a shelled egg in the ovary and two corpora lutea, and another obtained on 23 October had a thickened oviduct, no brood patch, and three corpora lutea. A female taken at Mandena on 16 September had a 30 × 20 mm unshelled egg in the oviduct and one ruptured ovarian follicle; the largest intact follicles were 10 and 7 mm.

WEIGHT—Female (1), 220 g; male (4), 150, 180, 185, 210 g.

SOFT PART COLORS—Bill: generally black, although in one adult male the mandible tip was gray; legs: dull or dark bluish gray to black; iris: deep red.

LOCAL NAMES—*Kotohake* (Berenty), *toloho* (Berenty, Manafiafy, Manombo, Marosohy).

Strigiformes

Tytonidae

Tyto alba affinis
Barn Owl

We have few records of the Barn Owl. Presumably it occurs throughout the region, particularly

in agricultural areas and as a human commensal (Goodman & Langrand, 1993). This species was heard calling at night in October and November in Tolagnaro proper and in September at Mandena. One Barn Owl was found dead along Route Nationale 13, 14 km west of Tolagnaro in an area of open agricultural land and eucalyptus plantation. This species occurs in gallery forest along the Mandrare River, particularly in the Malaza Forest, and in open areas outside of the forest.

DIET—The bird found dead along the road had an adult *Rattus* in its stomach. A small collection of pellets picked up in the Kaleta Reserve along the Mandrare River predominantly contained *Rattus rattus* and a few individuals of *Geogale aurita* and *Microcebus murinus*.

LOCAL NAMES—*Haka* (Manombo), *heko heko* (Berenty), *hora* (Marosohy), *vorondolo* (Berenty, Manafiafy).

Strigidae

Otus rutilus rutilus
Malagasy Scops Owl

The Malagasy Scops Owl was a common inhabitant from the Marovony Forest south through the Anosyenne and Vohimena mountains and along the coast to Petriky and west to the Mandrare River. This species occurs in a wide variety of habitats, including intact to disturbed humid, littoral, transitional, spiny, and gallery forests between near sea level and 1500 m. It is broadly sympatric with *Ninox* throughout the spiny forest region and locally in littoral forest at Petriky. This species is known from the Amboasary-Sud area (Langrand & Meyburg, 1984) and the RP de Berenty.

Two call types of this species have been reported from Madagascar. Rand (1936, p. 391) described the song as “tura-tura-tura-tura—,” i.e., a series of two-parted calls. Langrand (1990, p. 227), however, presented the song as “*hoo hoo hoo hoo hoo hoo hoo* or *broo broo broo*, 5–7 notes delivered at same pitch.” The “*hoo*” sequence clearly is a series of a single note, although “*broo*” may implicitly describe a two-noted call. Marshall (1978, plate 10) provides sonograms of the two song types.

Marshall (1978, p. 19) reported that Stuart Keith and the late C. W. Benson had observed that the voice of *Otus rutilus* was “variable” and, without elaboration, that “Keith heard them [i.e.,

the two song types] in different places." Our experience also has been that songs of *Otus rutilus* are geographically variable. The lower, slightly rougher, two-parted call is typical of birds we have heard in the RP de Berenty and parcel 2 of the RNI d'Andohahela and at other sites in western Madagascar (e.g., Kirindy Forest, RNI de Namoroka, RNI d'Ankarafantsika) in deciduous or spiny forest. The higher, smoother, single-note series, composed of 8–30 notes, is typical of birds of humid forests in southeastern Madagascar, as in parcel 1 of the RNI d'Andohahela, Mandena, Analalava, and Marovony and at localities farther north (e.g., PN de Ranomafana, RS d'Analamazaotra, RNI de Zahamena, RS d'Anjanaharibe-Sud, RNI de Marojejy). Marshall (1978) reported that Keith had heard one bird "switch" from one song type to another. In fact, Keith (in litt., 1990) heard "... both song types from the same patch of forest [at Fampamambato, near Maroantsetra]."

Such a pattern of geographic variation in song presumably would have a genetic basis. Only the nominate form of *Otus rutilus* is recognized on Madagascar, and we also have not detected any morphological or plumage variation that might correlate with voice. Further analyses of song variation in this species are planned to confirm the distinctiveness of the two vocal types, especially in ecotonal areas.

DIET—A single specimen taken in the Manantantely Forest had spiders (Araneae), Chilopoda, beetles (Curculionidae, Elateridae, Scarabaeidae), and Orthoptera (Gryllidae) in its stomach (Goodman & Parrillo, in press). In the Malaza Forest this owl fed on cicada nymphs. In the humid forest of the RNI d'Andohahela, this species was observed feeding on a *Calumma nasutus* chameleon and a large katydid.

BREEDING—Specimens taken between mid-September and late November had enlarged reproductive organs.

WEIGHT—Female (1), 112 g; male (3), 85, 97, 105 g; unknown (2), 94, 116 g.

SOFT PART COLORS—Bill: maxilla generally black but in one individual olive gray with dusky tip, and mandible black, black with yellowish tip, olive with whitish gray tip, or dull beige with black cutting edge; cere: olive gray or dull pink; legs: light or dull pink; claws: black or gray with black tips; iris: ochre yellow or lime yellow; orbital ring: reddish pink.

LOCAL NAMES—*Toro* or *torotoroka* (Berenty, Marosohy).

Ninox superciliaris White-browed Owl

The White-browed Owl was an inhabitant of dry areas, including spiny, gallery, and transitional forest, west of the lower western slopes of the Anosyenne Mountains. The only locality from which it was recorded outside of this range was the coastal forest of Petriky, which appears to be the eastern limit of this species' range in southern Madagascar. It is unknown from other littoral or any humid forests of the region, although in northern portions of the island it occurs in humid and littoral forest (Langrand, 1990; pers. obs.). Bluntschli collected two adult females on 11 and 18 November at Amboasary-Sud (AMNH, SMF), the same locality where Langrand and Meyburg (1984) found this species. It occasionally can be heard calling 2 hours before dusk and after dawn and on overcast days during the mid-morning or early afternoon.

This species is sympatric with *Otus rutilus* in spiny and locally in gallery forest. At dusk it vocalizes almost without exception before *O. rutilus*. During the day *Ninox* often roost in pairs and will perch on branches in the dense and darkest part of the forest.

BREEDING—Two eggs of this species were collected from a nest at Amboasary-Sud in mid-November (AMNH). At the RP de Berenty on 6 November a pair was observed, and one bird appeared to be incubating a nest in a hollow of a dead tree (OL).

LOCAL NAME—*Vorondolo* (Berenty).

Asio madagascariensis Madagascar Long-eared Owl

The Madagascar Long-eared Owl was recorded at several localities from the Marovony Forest south to the general Tolagnaro region. This species also has been reported from the RP de Berenty (Langrand, 1990). It occurs in a variety of habitats, including littoral, humid, and gallery forests from near sea level to about 1200 m. We have recorded this species at three locations in the general Tolagnaro area: in the pristine humid forest of Marosohy at about 350 m, in a large and relatively undisturbed patch of littoral forest at Manafiafy, and in a disturbed area at about 75 m in the Bezavona Forest. GR reported this species at Mandena. An undated specimen (BMNH) was collected near Fort-Dauphin sometime before the

turn of the 20th century. On 14 October Bluntschli collected one individual near Eminiminy (SMF).

In the humid forest of the RNI d'Andohahela (parcel 1) it was heard calling at 440, 810, and 1200 m. The typical call is a series of three to 10 "hangh" notes. One individual called on several days numerous times between dawn and 12h00 from a large *Canarium* tree with dense foliage; the call of this bird was a single "hangh." In late November and early December Madagascar Long-eared Owls were heard calling in the Marosohy Forest and in November were heard in the Marovony Forest.

DIET—Pellets collected at a roost site of this species in the Bezavona Forest contained amphibians (*Boophis madagascariensis*, *Platypelis grandis*), reptiles (*Uroplatus sikorae*), birds (*Centropus*, *Otus*, *Eurystomus*, *Hypsipetes*), bats (*Hipposideros commersoni*), lemurs (*Microcebus*, *Avahil*, *Hapalemur*), and rodents (*Eliurus minor*, *E. webbi*, *Rattus*, *Mus*) (Goodman et al., 1991, 1993).

BREEDING—In late December a juvenile bird was observed in the Bezavona Forest near a roost site.

LOCAL NAME—*Hankana* (Marosohy).

Asio capensis [hova]

Marsh Owl

The Marsh Owl has been observed on a few occasions. One was noted resting on a grass tussock on the shore of Lac Andriamibe, 5 km west of Tolagnaro. On several occasions this species was observed at night near Lanirano, 2 km north of Tolagnaro, perched on a fence around an illuminated compound. This species also has been observed in the RP de Berenty (OL; Nagata et al., 1992).

Caprimulgiformes

Caprimulgidae

Caprimulgus madagascariensis *madagascariensis*

Madagascar Nightjar

The Madagascar Nightjar was a common inhabitant of disturbed habitats along the coastal plain, particularly at forest edge, in open grass-

lands, agricultural areas, and in towns and villages from sea level to 850 m. The highest elevation at which we recorded this species was near Antseva, in an area of open grassland on the slopes of the Anosyenne Mountains. It also was a common inhabitant of open areas of spiny forest and along gallery forest. We did not record it in intact humid forests, such as those of the RNI d'Andohahela. Virtually all of the Madagascar Nightjars netted during our field studies ($N = 14$) were captured in open areas away from primary or tall secondary forest. The only exception was at Ankapoky, where they were captured in relatively open, intact spiny forest.

The vocalization of this species is one of the characteristic night sounds of the nonforested portions of the region, often starting before sunset and continuing to dawn. At some localities it was common; for example, in the early evening of 10 October near Manafiafy we found six individuals calling along a 0.5-km section of road. This species was common at night on roads in the Mandrare River Valley and also along the Route Nationale 13 between Amboasary-Sud and Tolagnaro. The dirt and tarmac roads are warm in the early evening because of absorption of heat from the sun during the day.

A single specimen from Tolagnaro (FMNH) is distinctly lighter in plumage coloration than typical *C. m. madagascariensis*. This variation suggests that further investigation of the taxonomic status of the southeastern Madagascar population is warranted.

DIET—Individuals collected during the 1989 and 1990 field seasons had beetles (Cerambycidae, Chrysomelidae: Alticinae, Curculionidae, Elateridae, Scarabaeidae: Hopliini), Odonata, and plant seeds in their stomachs (Goodman & Parillo, in press). Specimens taken by Milon also had insect debris in their stomachs (MNHN).

BREEDING—Bluntschli collected a nestling on 12 November near Amboasary-Sud (AMNH). On 24 September a juvenile was found on open ground at Petriky. Adult males taken between mid-September and late October generally had testes up to 9×4 mm. A female collected on 9 October at Ankapoky had a shelled egg in the oviduct, one corpus luteum, and a 14-mm ovarian follicle. A nestling, almost capable of sustained flight, was found at the edge of the forest in parcel 2 of the RNI d'Andohahela on 9 December.

WEIGHT—Female (4), 47.8 ± 2.5 (45–51) g; male (8), 39.8 ± 2.2 (37–43) g; combined (16), 41.9 ± 4.4 (36–51) g.

SOFT PART COLORS—Bill: maxilla black, and mandible black or pinkish brown with gray or black tip; legs: brown; claws: black; iris: dark brown.

LOCAL NAMES—*Kopaky* (Manombo), *langopaka* (Berenty), *langopaka tataro* (Manafiafy).

Caprimulgus enarratus
Collared Nightjar

There are few records of the Collared Nightjar. One was observed at 700 m in the humid forest of parcel 1 of the RNI d'Andohahela roosting during the day under the protection of a concave portion of a rocky outcrop. Bluntschli collected two individuals near Eminiminy in mid-October at approximately 300 m (AMNH, SMF). On 2 October an adult female was netted in the Marovony Forest in an area of intact forest (FMNH). The net was placed perpendicular to a trail in the forest and at least 700 m from the edge. On 26 December 1992 feathers of this species were found on the ground under a rock overhang along the Isedro Trail, parcel 1 of the RNI d'Andohahela, at 425 m. The bird was presumably killed by a human hunter. Milon et al. (1973) reported this species from the Tolagnaro area, but specific details are lacking.

DIET—The stomach of one collected individual contained beetles (Scarabaeidae: Melolonthinae and Tenebrionidae) (Goodman & Parrillo, in press).

BREEDING—The Marovony Forest specimen had a slightly enlarged ovary and thickened oviduct; the largest ovarian follicle was 2 mm.

WEIGHT—Female (1), 54 g.

SOFT PART COLORS—Bill: black; legs: dark brown; claws: black; iris: brown.

LOCAL NAMES—*Goapakala* (Marovony), *tatarao-ala* (parcel 1, RNI d'Andohahela).

Apodiformes

Apodidae

[Collocalia francica]
Mascarene Swiftlet

Milne Edwards and Grandidier (1879) mentioned that cliffs near Tolagnaro were an ideal site for the Mascarene Swiftlet to nest, but they provided no information that this species actually

bred in the area. Their general statement was accepted as evidence of this species occurring on Madagascar (Berlitz, 1946). This notion has been perpetuated in the literature. In the absence of any confirmed records, however, this species has been removed from the Madagascar bird list (Langrand & Sinclair, 1994).]

Zoonavena grandidieri [*grandidieri*]
Malagasy Spine-tailed Swift

The vast majority of our records of the Malagasy Spine-tailed Swift are from the edge of or above relatively dense closed-canopy humid forest between 50 and 1950 m. Localities include the forests of Analalava, Bezavona, and Marosohy and several sites in or near parcel 1 of the RNI d'Andohahela. We did not observe this species in littoral forest or in open disturbed lowland areas. It was occasionally noted in the spiny forest. The majority of records from this habitat are from along gallery forest, e.g., along the Mananara River near Hazofotsy and along the Mandrare River near the RP de Berenty. At the former locality this species was observed drinking on the wing from the river.

On several occasions this species was noted with other swifts. For example, on 9 December, at about 375 m in the Marosohy Forest, two *Zoonavena* were observed screening insects with three *Apus barbatus* and one *Cypsiurus parvus*.

BREEDING—Although no nest of *Zoonavena* was found in southeastern Madagascar, on several occasions it was observed flying around baobabs (*Adansonia*) in parcel 2 of the RNI d'Andohahela.

LOCAL NAMES—*Fililiotra* (Marosohy), *tsilotson'aka* (Manafiafy); both generic for swallows and swifts.

Cypsiurus parvus [*gracilis*]
African Palm Swift

The African Palm Swift was broadly distributed throughout open lowland areas from Marovony south to Petriky and west into the spiny forest to the Mandrare River. It is one of the characteristic lowland species of the region. The elevational range of this species was from near sea level to about 1200 m. In the RNI d'Andohahela (parcel 1) it was recorded flying over rivers and over the forest canopy at 440, 810, and 1200 m, although in such habitat it was much rarer than *Zoonavena*.

grandidieri. In parcel 2 of the same reserve, this species was distinctly more common over spiny and gallery forest. It was often observed screening insects over wetlands such as marshes and rice paddies, particularly in areas where scattered palms occurred, and in and around villages and towns. On numerous occasions it was noted screening insects in mixed-species flocks composed of other swift and swallow species. For example, on 26 December in open grassland areas at 150 m at the edge of the RNI d'Andohahela, near Eminiminy, we observed a mixed flock of five *Cypsiurus*, five *Apus barbatus*, and 10 *Phedina borbonica*.

BREEDING—On several occasions flocks of *Cypsiurus* were seen flying around palms (*Dypsis decaryi*) in parcel 3 of the RNI d'Andohahela (OL).

Apus melba [willisi] Alpine Swift

The Alpine Swift was observed at several widely separated localities. All of our records are from relatively open areas or at the forest edge, for example near or above the forests of Marovony, Analalava, Marosohy, Manafiafy, Mandena, Petriky, and Ankapoky. Milon et al. (1973) remarked that this species bred in the mountains north of Tolagnaro. Although we have no direct evidence to support this statement, we did receive a report that a colony of swift-like birds occurred along a rocky outcrop high in the Vohimena Mountains.

We often observed this species in mixed-species flocks. On 9 October two *A. melba* were noted with several *Phedina* in the spiny forest near Ankapoky; on 3 November four *A. melba* were foraging with four *A. barbatus* at the edge of the Marovony Forest; and on 11 November a mixed flock of *A. melba*, *A. barbatus*, and *Phedina* were observed near Analalava.

In the RNI d'Andohahela mixed flocks of *Apus* swifts were observed regularly over parcels 1 and 2 between October and December. Flocks generally contained 2–10 individuals. One group of 30 *A. melba* was seen flying over the summit of Trafonaomby in early December; most of the birds were in active wing molt, suggesting that they were adults that had already finished breeding. Over parcel 2, a flock of around 100 swifts was noted in mid-December, including approximately equal numbers of *A. melba* and *A. barbatus*.

Apus barbatus [balstoni] African Black Swift

The African Black Swift was observed on several occasions in various portions of the area. It was recorded near the forests of Marovony, Marosohy, and Petriky and near the villages and towns of Manantenina, Bemangidy, Tolagnaro, and Ambovombe. We found no evidence of it breeding in this region, and many of our records may be of migrant flocks. It was noted several times in flocks with *Zoonavena*, *A. melba*, *Cypsiurus*, and *Phedina* (see those species accounts for specific records).

Coraciiformes

Alcedinidae

Alcedo vintsioides vintsioides Malagasy Kingfisher

The Malagasy Kingfisher was commonly found near water in forest and open areas from the Marovony Forest south through the Anosyenne and Vohimena mountains to Petriky and west to the Mandrare River, from near sea level to about 850 m. On the lower slopes and east of the Anosyenne Mountains it was found in a variety of habitats from open water (fresh and brackish) such as lakes, coastal lagoons, and rice paddies to streams and wet areas in humid and littoral forest and in open grassland away from water. In this region we only have a few records of this species away from water. In the RNI d'Andohahela (parcel 1) it was seen frequently on rivers in primary forest up to 850 m. In spiny forest areas it generally is restricted to gallery forest and river margins. This species is at least occasionally crepuscular; we netted one individual about 1 hour before sunrise.

DIET—The stomachs of all specimens contained insects, and in one case they were identified as orthopterans.

BREEDING—Birds collected between mid-September and late November included males with testes up to 5 × 3 mm and females with ovarian follicles 4 mm in diameter.

WEIGHT—Female (5), 18.1 ± 2.8 (14.5–21.5) g; male (3), 15.3 ± 1.0 (14.5–16.5) g; combined (15), 16.9 ± 2.5 (13.0–21.5) g.

SOFT PART COLORS—Bill: black or brown and

sometimes orange or reddish at base; legs and claws: orange or reddish orange; iris: dark brown.

LOCAL NAMES—*Bintitra* (Berenty), *revitsy* (Manafiafy, Manombo, Marosohy), *vintsy* (Manafiafy).

Ispidina madagascariensis madagascariensis

Madagascar Pygmy Kingfisher

The Madagascar Pygmy Kingfisher was a relatively common inhabitant of a variety of forest types from the Marovony Forest south through the Anosyenne and Vohimena mountains to the Tolagnaro region and west through scattered locations in the spiny forest region to the Mandrare River. Its elevational range was from 20 to 1200 m. This species was particularly common in pristine and relatively intact humid forests such as Marovony, Marosohy, Bezavona, RNI d'Andohahela (parcel 1), and Manantantely and to a lesser extent in littoral and spiny forest. One was collected by Bluntschli at Eminiminy on 28 October (SMF). Spiny forest sites include the Ankapoky Forest, near Hazofotsy, and near Amboasary-Sud (Langrand, 1990). A single individual was present in the RP de Berenty for three days in May 1986, after which it disappeared.

This species was observed crossing open areas such as rice paddies, agricultural fields surrounded by thick secondary forest, and eucalyptus plantations. In the Bezavona Forest several birds were netted along a stream coursing through bamboo and eucalyptus at least 500 m from the forest edge.

DIET—The stomach of a collected bird contained ants (Formicidae) and remains of a small reptile (Goodman & Parrillo, in press). One specimen collected in littoral forest at Mandena had bones of a small frog in its stomach. In the Marosohy Forest at 750 m this species was observed taking stream-dwelling *Mantidactylus lugubris*. Two of these frogs appeared to be chasing one another across open rocks along a stream when a kingfisher caught one of the frogs. At the same locality a collected bird had frog bones in its stomach. At 850 m in parcel 1 of the RNI d'Andohahela, an *Ispidina* caught and ate a chameleon (*Calumma nasutus*). The body of the chameleon was about the same length as the kingfisher's head. The chameleon was dispatched by rapid flicks of its head against a branch. The bird kept the prey in its bill for several minutes after capture while calling quietly. The kingfisher then

swallowed the chameleon whole, head first, in about 20 seconds. In the same reserve, at 440 m, an *Ispidina* was seen hunting before sunrise in near total darkness.

BREEDING—There was considerable variation in the development of the reproductive organs of adults collected between mid-September and late December, from enlarged to small.

WEIGHT—Female (3), 15.5, 16.5, 22 g; male (3), 15, 19, 23.5 g; combined (16), 18.9 ± 2.5 (15.0–23.5) g.

SOFT PART COLORS—Bill: generally completely orange or reddish orange but a few individuals with dusky brown on central portion of maxilla; legs and claws: orange or reddish orange; iris: brown.

LOCAL NAME—*Revitsy'ala* (Manafiafy, Marosohy).

Meropidae

Merops superciliosus superciliosus

Madagascar Bee-eater

The Madagascar Bee-eater was relatively common in open and heavily disturbed areas, particularly along the coastal plain and river margins between near sea level and 750 m. On the lower slopes and east of the Anosyenne Mountains it commonly was seen in gardens of villages and towns, at the edge of degraded humid and littoral forests, and in agricultural fields or grasslands and occasionally flying over relatively intact forest parcels. This species was not recorded in 7 weeks of bird survey work in parcel 1 of the RNI d'Andohahela (October–December), despite 23.5 hours of canopy watching. It was observed, however, at about 1000 m in degraded transitional forest between Trafonaomby and Esomony. In the spiny forest region it was noted in a variety of habitats, including in intact and degraded spiny forest, along riverbanks, at the edge of gallery forest, in eucalyptus and sisal plantations, and along roads. In the Bealoka and Malaza forests this species was rare or absent between the months of December and February.

DIET—The stomach of a collected bird contained Hymenoptera (Apoidea) (Goodman & Parrillo, in press).

BREEDING—Birds collected between late September and early November included a male with testes 6×4 mm and a female with a thickened oviduct and ovarian follicles 4 mm in diameter.

Pairs were observed copulating in Tolagnaro on 15 October and in the Malaza Forest on 10 October. Nest holes were relatively common in the banks of the Mandrare River between Berenty and Bealoka, along the Mananara River, and along the Route Nationale 13 between Amboasary-Sud and Tolagnaro.

WEIGHT—Combined (3), 39.5, 45, 48 g.

SOFT PART COLORS—Bill: black; legs: grayish brown or slate gray; iris: dark brown.

LOCAL NAMES—*Kirikirioky* (Berenty, Manafafy, Marosohy), *kirio* (Manombo), *tsikiriokirioke* (Berenty).

Coraciidae

Eurystomus glaucurus glaucurus

Broad-billed Roller

The Broad-billed Roller migrates to east Africa during the austral winter. Our earliest record of it in southeastern Madagascar is 30 September, and the latest record is 2 March. It was a relatively common bird throughout the area from near sea level to 1600 m. In humid portions of the region, from the Anosyenne Mountains east to the sea coast, this species occurs in open habitats, including patches of *tavy* deep in the forest, open grasslands, agricultural areas, tree plantations, gardens in villages and towns, and open secondary forest. In intact humid forest it is rare or absent. In dry areas it is a relatively common resident of spiny forest and gallery forest and open degraded areas. Several specimens were collected at Amboasary-Sud in late October and early November (AMNH, SMF).

DIET—The stomach contents of one collected individual contained remains of Elateridae and Scarabaeidae beetles (Goodman & Parrillo, in press). Like *Falco concolor*, *Eurystomus* arrives in southeastern Madagascar during a period that coincides with cicada emergence, on which they feed extensively. This species has been observed skimming the water of the Mandrare River; it was uncertain whether the bird was drinking or hunting.

BREEDING—A female obtained on 2 November at the edge of the Marovony Forest had an enlarged ovary and thickened oviduct, and the largest ovarian follicle was 7 mm. The bird did not have a brood patch. Active nests have been found from early November to early February.

At the RP de Berenty this species arrives in

large numbers and tends to take over nest sites in tree hollows and cavities that may have recently been used by *Coracopsis* or *Agapornis*. *Eurystomus* is aggressive and highly vocal during the breeding season. Favorite nesting trees are dead *Acacia rovumae*, *Neotina isoneura*, and *Tamarindus indica*.

WEIGHT—Female (1), 180 g.

SOFT PART COLORS—Bill: yellow with slight orange cast; legs: brownish olive; claws: black; iris: brown.

LOCAL NAMES—*Tsiraraka* (Berenty), *teraratsy* (Marovony).

Brachypteraciidae

Brachypterus leptosomus

Short-legged Ground-Roller

The Short-legged Ground-Roller was relatively common in the intact portions of the Marosohy Forest between 700 and 1100 m. It was generally noted in areas with large trees, wet ground, and a relatively open understory. Although no nests were found, birds were frequently flushed up from the ground next to hollows and crevices under tree buttresses and roots. At least 11 birds were observed along a portion of the Entseva-Anakara trail about 1.5 km long between 750 and 825 m. Virtually each day during 1 week in late November individuals were found in the same places along this trail. Thus, our impression was that these were birds on territory. If so, this would give a density of approximately 3.5 pairs/km of trail. In the Marosohy Forest this species appears to occupy a higher elevational zone than *B. squamiger*. In parcel 1 of the RNI d'Andohahela, *B. leptosomus* was observed at 440, 810, and 1200 m, and the local density was not as high as in the Marosohy Forest. In early October 1995 feathers of this species were found along the Tanatana Trail between Isaka-Ivondro and Eminiminy. These remains were presumably of birds taken by hunters using slingshots.

The song of this species is a distinctive deep, low, and whistled “whop” repeated every 1–2 seconds. The song is given from a horizontal perch 5–30 m high. Individuals regularly can be heard countersinging, and apparently territorial birds on adjacent territories may chase each other between song bouts.

DIET—One individual was captured after it was attracted to a large beetle captured in a mist net.

BREEDING—A male taken on 2 November in the Marosohy Forest had testes that were 12×8 mm (left) and 8×4 mm (right). A fledged juvenile was noted at 440 m along the trail between Isakalivondro and Eminiminy in early January.

SOFT PART COLORS—Bill: dark brown or horn brown with dull yellow flange; mouth lining: dull yellow; legs: dirty brownish yellow to golden brown merging to greenish yellow toes; claws: brownish yellow or dull greenish yellow; iris: brown.

WEIGHT—Combined (2), 183, 186 g.

LOCAL NAME—*Pokafo* (Marosohy).

Brachypterus squamiger

Scaly Ground-Roller

The Scaly Ground-Roller was only noted in areas with relatively intact closed-canopy humid forest between 70 and 525 m. Records from in or near parcel 1 of the RNI d'Andohahela include several individuals along the Enakara–Antseva trail between 325 and 425 m; one bird along the Isedro Trail, east of the Col d'Ambaromanaha, at about 525 m; and at least six pairs along 2.3 km of trail at our 1995 camp at 440 m. Feather remains of one individual were found in a rock shelter along the Isedro Trail at 425 m and were probably from an individual hunted by humans. A specimen was taken near Eminiminy on 8 October by Bluntschli (SMF). This species also was observed in the Manantantely Forest at 70 m.

Brachypterus squamiger has a call similar to that of *B. leptosomus*, but the whistle is somewhat higher in pitch and repeated only every 5–10 seconds. The song is given from perches 0.1–5 m high. No evidence of countersinging between territorial individuals was found in this species.

BREEDING—A male taken on 21 October at 440 m in parcel 1 of the RNI d'Andohahela had testes 5×4 mm (left) and 4×3 mm (right).

SOFT PART COLORS—Bill: dull blackish brown with slightly lighter cutting edge; legs: pinkish orange; claws: dull white; iris: brown; fleshy eye ring: orangish pink.

WEIGHT—Male (1), 155 g.

LOCAL NAME—*Tatarobobaky na lakopaky* (parcel 1 of the RNI d'Andohahela).

Atelornis pittoides

Pitta-like Ground-Roller

The Pitta-like Ground-Roller was observed at scattered localities in and near parcel 1 of the RNI

d'Andohahela, all of which were in pristine or relatively intact humid forest. Records include individuals on the Entseva–Anakara and Anakara–Ranomafana-Sud trails between 800 m and 1150 m, one bird on the west side of the Col d'Ambaromanaha at about 1100 m, and at least four pairs along 1 km of trail just above our 1995 camp at 1200 m. Along this trail it was sympatric with *A. crossleyi*. This site and PN de Ranomafana (M. Putnam, pers. comm.) are the only known localities where the two *Atelornis* species share adjacent or overlapping territories. *A. pittoides* was not recorded anywhere else along the 1995 altitudinal transect in the RNI d'Andohahela except in transitional forest north of Trafonaomby at 1500–1700 m, where it also was very common and where *A. crossleyi* was apparently absent.

BREEDING—Two males taken on 9 November had testes (left and right, respectively) that were 6×4 mm and 5×3 mm, and 7×5 mm and 6×3 mm. These two specimens did not have brood patches.

SOFT PART COLORS—Bill: black; legs and claws: dull pinkish gray; iris: brown.

WEIGHT—Male (2), 85.5, 89.5 g.

LOCAL NAME—*Fantsasatry* (Marosohy).

Atelornis crossleyi

Rufous-headed Ground-Roller

The only forest in which we found the Rufous-headed Ground-Roller was parcel 1 of the RNI d'Andohahela, within an elevational range of 800–1800 m. During the 1995 inventory of the reserve, this species was common at 1200 m and 1500 m. The highest densities were at 1500 m, with at least eight pairs along 2 km of trail. Single pairs or individuals were also found at 810 and 1800 m. Up to three singing males were audible from one point-count site at 1500 m.

Leptosomatidae

Leptosomus discolor [*discolor*]

Cuckoo Roller

The Cuckoo Roller occurs from the Marovony Forest south through the Anosyenne and Vohimena mountains to Petriky and west across the spiny forest to the Mandrare River. This species was occasionally heard in Tolagnaro. It was found at elevations between near sea level and 1800 m.

The Cuckoo Roller occurs in a variety of habitats from pristine to slightly disturbed humid, littoral, and spiny and gallery forest to heavily degraded secondary forest, transitional habitat between dry and humid forest, open areas at the forest edge, and occasionally agricultural areas several kilometers from forest. This species also moves between habitats. For example, on 28 December 1992 a Cuckoo Roller was observed flying and calling over the humid/transitional forest on the west side of parcel 1 of the RNI d'Andohahela, below the Col d'Ambatomanaha, and this individual continued flying down the slope into spiny forest a few kilometers away.

Although relatively common in humid forests, this species was rare in littoral forest, where our only record is from the Petriky Forest. Specimens from potential coastal areas include one taken 7 km north of Tolagnaro (MNHN). The distinctive call of this species was often our means of recognizing its presence in a given area, and thus lack of records from some forest sites may be more a function of the time of year birds vocalize than of their actual distribution.

Occasionally *Leptosomus* will perform the aerial display in groups. On 7 June about 10 individuals were seen and heard flying high over the RP de Berenty, and on 18 November in parcel 1 of the RNI d'Andohahela, four males (including one subadult) spent 25 minutes continuously calling and flying over a tree in which a female was perched. An interesting aspect of this display is that the female appears to call using the same phrase as the males.

DIET—The general hunting technique involves perching motionless, watching, and then sally-gleaning insects, caterpillars, and small vertebrates off vegetation substrate. An individual taken 7 km north of Tolagnaro (MNHN) on 9 March had debris of insects, including cicadas and grasshoppers, in its stomach.

BREEDING—A nest of *Leptosomus* placed in a *Neotina isoneura* tree was found in the RP de Berenty. The specimen noted above from north of Tolagnaro had no enlarged ovarian follicles.

LOCAL NAMES—*Vorondreo* and *treo-treo* (Berenty).

Upupidae

Upupa epops marginatus Hoopoe

In southeastern Madagascar the Hoopoe was a locally common inhabitant of open or disturbed

lowland areas; in other areas of the island this species is known to occur up to 1500 m (Langrand, 1990). Our northernmost record along the seacoast is from the Manafiafy region. The vast majority of our records are either from open areas along the coastal plain and adjacent to littoral forest, such as Manafiafy, Mandena, Itapera, and Petriky, or from spiny forest and gallery forest. We found no evidence that this species inhabits humid forest. In dry areas it appears to prefer slightly degraded and more open forests such as Bealoka and Berenty. There are three specimens taken at Amboasary-Sud in late October and mid-November (AMNH, SMF). The form occurring in the area is *U. e. marginatus*. On the basis of plumage and song, this subspecies is markedly different from other forms of *U. epops* and probably warrants recognition as a distinct species.

DIET—Chicks in a nest at Bealoka were fed crickets and beetles by the adults.

BREEDING—Active nests have been found at Bealoka in *Tamarindus* trees on 9 October and 14 November. One nest had six eggs. Two specimens taken on 18 September at Mandena included a male with testes 8×4 mm and a female with a 10×8 mm ovary and ovarian follicles up to 2 mm in diameter; another pair taken on 8 October in the Ankapoky Forest had small gonads.

WEIGHT—Female (2), 57, 72 g; male (2), 69, 89 g; combined (5), 72.4 ± 11.5 (57–89) g.

SOFT PART COLORS—Bill: black or dark gray at base merging to black tip; legs: light to dark grayish brown or dull black; claws: black; iris: dark brown.

LOCAL NAME—*Tsikodara* (Bealoka, Berenty, Manafiafy, Marosohy).

Passeriformes

Eurylamidae

Philepitta castanea Velvet Asity

The Velvet Asity was recorded at a variety of sites, all of which are humid forests. This species was relatively common in the Marosohy Forest between 350 and 1000 m and in parcel 1 of the RNI d'Andohahela between 440 and 1900 m. Records from other areas of parcel 1 include along the Tanatana Trail at about 600 m and on the east side of the Col d'Ambatomanaha at about 1100 m.

Our only other observations of it from southeastern Madagascar are a pair in the Marosalohy Forest at about 1125 m and an adult male netted at the edge of the Marovony Forest in a low-lying area with secondary scrub and *Ravenala* at about 50 m. Appert (1985) reported it from the forest of Bemangidy. One specimen was collected in 1756 near Fort-Dauphin (Stresemann, 1952).

DIET—The stomachs of two individuals taken 30 km NNW Fort-Dauphin (MNHN) contained seeds, vegetable debris, and fruits. In the RNI d'Andohahela (parcel 1) this species was noted feeding on the red berries of *Oncostemon*.

BREEDING—Several specimens taken in the Marosohy Forest in late November and early December were in or approaching breeding condition based on testes size. This group included males in breeding plumage with well-developed wattles and brightly colored soft parts, females about to lay eggs, and males in "female" plumage. Several males in breeding plumage and none of the males in female plumage had defined brood patches. Little is known about the breeding system of this species, although Langrand (1990) mentioned that both parents feed the young.

In the RNI d'Andohahela (parcel 1), a female-plumaged bird was recorded nest building at 810 m on 2 November. The nest was made of long strips of moss or lichen woven into a 10-cm-diameter ball suspended from a 1-cm-diameter branch about 3 m off the ground. On 19 November at 1500 m in the same reserve, a female-plumaged individual was seen gathering nest material, also 5–10-cm-long strips of moss or lichen.

Several apparent leks of this species were recorded in parcel 1 of the RNI d'Andohahela. On 11 November at 1200 m, three male-plumaged birds spent 20 minutes calling vigorously in an area (not otherwise distinguishable from surrounding vegetation) about 10 × 10 m. Two males had completely black plumage and large wattles, and one male had some yellow fringes on the mantle and belly feathers and only small wattles. A fourth bird in female plumage also was present and chased and fought with one of the black males. This bird may have been a female-plumaged male. One of the completely black birds had a much larger wattle than the other; the lobes of the wattle almost touched over the head and extended to within 2 mm of the tip of the bill. This bird fought vigorously with the other black-plumaged bird, which apparently chased the large-wattled bird away.

On 8 November at 1200 m in the same reserve,

two birds in female plumage chased each other through the understory and fought briefly. One of these birds had a single tertial feather with a black outer web. This feather also had a yellow fringe. On 20 November at 1500 m, two black-plumaged males perched on branches 2 m from each other, and each bird flicked both wings slightly out and away from the body, exposing the yellow feathering on the carpal joint. After about 5 minutes of wing-flicking and singing or calling, they fought briefly in the middle of a bush before one bird flew about 20 m away. Both birds had smaller (but normal-sized) wattles compared with those of the male seen on 12 November.

WEIGHT—Female (9), 36.6 ± 1.9 (33.5–39.5) g; male (8), 33.4 ± 4.0 (25.5–38.5) g; combined (51), 35.7 ± 3.9 (25.5–47.0) g.

SOFT PART COLORS—Adult Male Breeding

Plumage—Bill: black often with yellow flange at base of gape; legs: yellowish green or greenish brown merging to yellowish green feet; claws: gray; iris: dark brown; fleshy caruncle: brilliant lime green with brilliant electric blue line above eye and black underside. One male in breeding plumage had a fleshy wattle greatly reduced in size and colored dark olive green above eye and the balance was black.

Birds in Female Plumage—Bill: dark brown or black with yellow flange at base of gape; mouthparts: yellow; legs: olive brown, yellowish green, or greenish brown merging to yellowish green feet; claws: dark gray; iris: dark brown; orbital ring: sometimes slightly developed and yellowish green or dull lime green.

LOCAL NAME—Asity (parcel 1 of RNI d'Andohahela).

Neodrepanis coruscans

Sunbird-Asity

The only localities where we found this species were in the Marosohy Forest and the adjacent RNI d'Andohahela (parcel 1) between 425 and 1350 m. The lower elevation records include a bird in the Marosohy Forest at 425 m and a male west of Eminiminy between 440 and 600 m. The lowest elevation at which this species was recorded in the RNI d'Andohahela was 810 m. At 1350 m, it was recorded in forest about 50 m elevational distance below where *N. hypoxantha* were seen regularly; *N. hypoxantha* was along the crest of a ridge, whereas *N. coruscans* was present in adjacent contiguous forest on the slopes of the same ridge. Hence the altitudinal separation of these

two species was sharply defined. Appert (1985) reported a *Neodrepanis*, presumably *coruscans*, from the Bemangidy Forest.

Several birds in the RNI d'Andohahela (parcel 1) at 810 m were in immature male plumage, with a few blue-fringed feathers on the scapulars or coverts and rump, a small (1 mm diameter) bluish wattle over the eye, and dull yellow underparts. Some of these individuals may have been males in "female" plumage, a direct parallel to the situation already described for *Philepitta*. Also present in the same area at the same time were males in full breeding plumage.

Males when flying make a noticeable whistling or humming sound with their wings. This sound is not produced by female or immature male *N. coruscans*, and it is not as noticeable as in male *N. hypoxantha*. In many bird species such mechanical noises are produced by modified (often highly emarginated) outer primaries. The first (outermost) primary in male *N. hypoxantha* is broadly emarginated, whereas no such broad emargination is apparent in the primaries of adult male *N. coruscans*.

DIET—In the Marosohy Forest at about 900 m an adult male Sunbird-Asity was observed feeding at the flowers of *Sloanea*. The stomach contents of one bird consisted of small insects and some liquid that may have been flower nectar. A female at 810 m fed in a clump of *Bakerella* flowers.

BREEDING—An adult male in breeding plumage taken on 25 November had a well-developed caruncle and brightly colored eye ring but small testes. All males in breeding condition lack brood patches. A female at 810 m on 2 November was collecting nest material (short strips of lichen or moss), and a male at 810 m on 6 November, which flew back and forth across a river with food, presumably was feeding young.

SOFT PART COLORS—Bill: black except at base of mandible, which varies from dark green to brilliant green; legs and claws: black; iris: brown; fleshy area around eye: deep cobalt blue (males in breeding condition).

WEIGHT—Female (1), 7.0 g; male (4), 6.5 ± 0.1 (6.4–6.7) g; combined (5), 6.6 ± 0.2 (6.4–7.0) g.

LOCAL NAME—*Soy* (Marosohy). This is the same name used for *Nectarinia* spp.; the informant may have confused these two genera.

Neodrepanis hypoxantha Yellow-bellied Sunbird-Asity

Our only records of the Yellow-bellied Sunbird-Asity are from parcel 1 of the RNI d'Andohahela

between 1350 and 1950 m, in which zone it was common. This species was absent from transitional forest at 1700 m north of Trafonaomby and along the western slope of the main massif. In late May one individual was observed in the RNI d'Andohahela between Esomony and Vohibaka at 1150 m (Langrand & Sinclair, 1994; OL).

A description of juvenile birds has been presented by Hawkins et al. (in press). Birds apparently having completed postjuvenile molt were noted on several occasions at 1500 m (20 and 22 November) and 1900 m (28 and 30 November). These birds resembled female *N. coruscans* in that they had dull olive underparts except for a pale yellow area on the flanks. The wing coverts had a narrow pale buff fringe. The major distinction between *N. hypoxantha* and *N. coruscans* at this age is the call, which in the former species is much higher pitched and generally a single note.

DIET—At 1500 m, female and immature male-plumaged birds both fed from the long-spurred flowers of *Bakerella*. The birds did not use the length of their bill to reach the nectar source but instead inserted their very long tongues. Other food plants noted (both flowers apparently visited for nectar) included *Gaertnera* and *Medinilla*.

On 1 December, at 1960 m on the summit of Trafonaomby, a male *N. hypoxantha* disputed access to a clump of *Bakerella* flowers with two female *Nectarinia souimanga*. It was difficult to tell the outcome of the dispute, but the *N. souimanga* were continually present at the site and *Neodrepanis hypoxantha* appeared to be only a casual visitor, suggesting that the sunbird was the dominant species.

BREEDING—A bird netted on 22 November in female plumage had a brood patch, and a specimen collected on 1 December had only 15% of the skull ossified. Males in breeding plumage lacked brood patches. In the RNI d'Andohahela (parcel 1) a nest was found on 2 November at 1850 m that contained two eggs. The nest was oval in shape and suspended from a lateral branch of a 2.5-m sapling on a steep slope. The nest was collected on 4 December and the eggs contained small embryos. Only the female was seen brooding the eggs, but when the nest was collected both the male and the female vigorously mobbed the intruder.

On 19 November at 1500 m an immature male-plumaged bird (with individual blue-fringed black feathers on lower and upper scapulars and tertials and a half-sized blue wattle) displayed to a female-plumaged bird by fluffing out the body

feathers, drooping the bill and head forward, and depressing the tail. During this display the male called vigorously, a series of single hissing notes.

SOFT PART COLORS—Adult Male in Breeding

Plumage—Bill: at base dark cobalt blue posterior to nostril, light cobalt blue above (dorsally) and connecting nostrils, bright lime green around nasal operculum, and balance of bill black; legs: brownish black; claws: black; iris: dark brown; fleshy caruncle: complex pattern of color and slightly variable with the lower half (below eye) dark cobalt blue, lateral dull dark green stripe the width of the eye and directly posterior to it, above eye light cobalt blue, sometimes bright sky blue, and area between eye and base of bill dark cobalt blue. A male molting into breeding plumage had a dull cobalt blue fleshy caruncle and some brilliant blue and green skin around the nostrils. **Female Plumage**—Bill: dull brownish black; legs: dark grayish brown or brownish black; foot pads: dull yellow; claws: black; iris: dark brown.

WEIGHT—Presumed female (3), 7.0 ± 1.0 (6.0–8.0) g; male (3), 7.5 ± 0.5 (7.0–8.0) g; combined (8), 7.2 ± 0.8 (6.0–8.0) g.

Alaudidae

Mirafr a hova

Madagascar Bush Lark

The Madagascar Bush Lark was common in degraded open areas from the Marovony Forest south through the Anosyenne and Vohimena mountains to Petriky and west to the Mandrare River from near sea level to over 1700 m. This species was abundant along the eastern coastal plain in open grasslands, agricultural fields, heathlands, and degraded areas near the littoral forests of Manafiafy, Itapera, Mandena, and Petriky. Further inland, in regions with lateritic soils it was less common, although it was locally common in some upland areas, such as agricultural fields in the Manampanihy River valley between the Col de Managotry and Ranomafana-Sud. During the 1995 inventory of the RNI d'Andohahela (parcel 1), this species was not found in humid forest and was only present in open grassland adjacent to the transitional forest between 1500 and 1700 m. In the spiny forest region it occurs in a variety of habitats from degraded and slightly open areas in spiny forest to river plains, degraded areas, and sisal plantations.

DIET—Stomach contents of collected birds included beetles (Curculionidae, Elateridae, Scarabaeidae, Tenebrionidae), ants (Formicidae), and flies (Asilidae) (Goodman & Parrillo, in press).

BREEDING—A male and female taken near Manafiafy in the first half of October had testes 6×4 mm and a slightly enlarged ovary, with thickened oviduct and ovarian follicles up to 3 mm in diameter, respectively; only the female had a brood patch. Also, during the same period another collected bird had a partially ossified skull and small gonads. A male taken at Ankapoky on 12 October had testes 3×2 mm and no brood patch.

WEIGHT—Combined (5), 19.6 ± 2.2 (17.5–23.0) g.

SOFT PART COLORS—Bill, legs, and claws: light pink to horn gray; iris: brown.

LOCAL NAMES—*Borisy* (Marosohy), *bria* (Manombo), *jorioke* (Berenty).

Hirundinidae

Riparia paludicola [cowani]

Brown-throated Sand Martin

The only known record of the Brown-throated Sand Martin in southeastern Madagascar is five individuals flying over a marsh surrounded by transitional forest at 1500 m, north of Trafonaomby. In other parts of Madagascar, it is rare below elevations of 500 m (Langrand, 1990). The field work conducted in the southeast was generally in lowland areas, which might account for the lack of sightings elsewhere in this region.

Phedina borbonica *madagascariensis*

Mascarene Swallow

This species was recorded sporadically between sea level and 1950 m elevation. It often is a human commensal, nesting in abandoned buildings and various types of structures. It was common along the coastal plain between Manantenina and Tolagnaro, where small groups were observed foraging over villages and agricultural areas. We recorded this species on numerous occasions in the interior of large intact humid forests, e.g., the Marosohy Forest and parcel 1 of the RNI d'Andohahela. In the spiny forest region it was distinctly less common, except for areas along rivers and near villages or towns, such as the RP de Berenty, Ambovombe, and Amboasary-Sud. We found no evidence of this species breeding along natural rock faces, in caves, or in tree cavities; in southeastern Madagascar it clearly favors human-made structures for nesting sites.

This species was often observed in mixed-species flocks with other aerial foraging insectivores, such as *Zoonavena*, *Apus barbatus*, *A. melba*, *Cypsiurus*, and *Hirundo rustica*.

DIET—A specimen taken in the Tolagnaro area had beetle (Elateridae, Scarabaeidae), Homoptera, and ant (Formicidae) remains in its stomach (Goodman & Parrillo, in press).

BREEDING—Different active nests were found in Tolagnaro: on 14 September with four eggs, on 17 September with two eggs, on 6 November with three nestlings about 10 days old, and on 15 October with four eggs. Collected females in breeding condition had brood patches, whereas males lacked brood patches. All breeding sites found to date in the region are in human-made structures.

WEIGHT—Combined (4), 21.3 ± 1.0 (20.0–22.5) g.

SOFT PART COLORS—Bill: black; legs: dark brown; claws: black; iris: brown.

LOCAL NAMES—*Fililiotra* (Marosohy), *tsilotson'aka* (Manafiafy); both are generic for swallows and swifts.

Hirundo rustica subsp.

Barn Swallow

This species is a relatively uncommon migrant to Madagascar during the boreal winter (Langrand, 1990). Our only record of it in southeastern Madagascar is one observed at Tolagnaro on 12 November in a flock of *Phedina borbonica*.

Motacillidae

Motacilla flavigaster

Madagascar Wagtail

The Madagascar Wagtail was infrequently observed from the Marovony Forest south through the Anosyenne and Vohimena mountains and along the coastal plain north to the Manantantely Forest. Its elevational range in the region is from sea level to 1950 m. Most records are from wet open areas, such as pastureland, rice paddies, and the margins of rivers and marshes. In humid forest (e.g., parcel 1 of the RNI d'Andohahela) it is almost always along streams. We found this species near or adjacent to the forest parcels of Marovony, Analalava, Marosohy, Manafiafy, Itapera, Mandena, Bezavona, and Manantantely. We observed it on a few occasions in eucalyptus plantations

bordered by small streams. West of the Anosyenne Mountains, in the spiny forest region, it was distinctly rare and generally confined to the margins of permanent rivers such as the Mandrare or, in the RP de Berenty, open areas adjacent to the tourist bungalows.

Salvan (1970) reported that this species may be a seasonal migrant in the southern portion of the island, being absent during the austral winter. During the period of the QIT field studies, September through December (austral summer), we saw no change in the abundance of this species.

DIET—Individuals collected in 1989 and 1990 had the following food remains in their stomachs: beetles (Curculionidae, Elateridae), Homoptera, and Hymenoptera (Goodman & Parrillo, in press). This species was observed along the coastal beach feeding on insects in tidal flats.

BREEDING—In mid-October an adult Madagascar Wagtail was observed carrying food, presumably to a nest. Specimens taken at Manafiafy in late October were an immature with small testes and a bursa 6×2 mm and an adult male with testes 6×4 mm and no brood patch. A male taken at the edge of the Marovony Forest on 30 October had testes 4×3 mm and a cloacal protuberance, and a female taken at the same time had a slightly enlarged ovary and a brood patch. On 31 October we observed an adult bringing food to a nest placed in a crevice of a large boulder resting in the middle of a stream along the Enakara–Antseva trail (325 m elevation). The stream formed the boundary between the Marosohy Forest and a rice paddy. A similarly placed nest was found along the Andranohela River at about 400 m.

SOFT PART COLORS—Bill, legs, and claws: black or brownish black; iris: dark brown.

WEIGHT—Combined (10), 22.3 ± 0.9 (21–24) g.

LOCAL NAME—*Triotrio* (Berenty, Manafiafy, Manombo, Marosohy).

Campephagidae

Coracina cinerea cinerea and *Coracina cinerea pallida*

Ashy Cuckoo Shrike

The Ashy Cuckoo Shrike was regularly noted in primary and secondary humid forest from the Marovony Forest south through the Anosyenne and Vohimena mountains to Manantantely, from 20 to 1950 m. During the 1995 inventory of parcel 1 of the RNI d'Andohahela this species ap-

peared equally common at all altitudinal zones sampled between 440 and 1950 m. Appert (1985) reported this species from near Bemangidy. It also has been collected 30 km NNW Fort-Dauphin (MNHN) and near Eminiminy (AMNH). The only record we have from littoral forest is a pair at Manafiafy on 10 October (FMNH), although this species was observed in or near Mandena (GR). A specimen was collected in 1756 near Fort-Dauphin (Stresemann, 1952). All material examined from the Anosyenne Mountains and east to the coast is referable to *C. c. cinerea*. The Ashy Cuckoo Shrike also occurs in riparian habitat, such as the RP de Berenty, Bealoka, and Hazofotsy and along the Mananara River, where the subspecies presumably is *C. c. pallida*.

In early October 1995 feathers of this species were found along the Tanatana Trail between Isaka-Ivondro and Eminiminy. These remains were presumably those of a hunted individual killed with a slingshot.

DIET—Stomach contents of birds we collected included Diplopoda, spiders (Araneae), beetles (Curculionidae, Elateridae, Scarabaeidae, Tenebrionidae), Lepidoptera (larvae), Isoptera, Homoptera, and Orthoptera (Tettigoniidae) (Goodman & Parrillo, in press). A large millipede was found in the stomach of one bird (MNHN). The stomach contents of a bird collected in the Analalava Forest from a mixed-species foraging group consisted of fruits and parts of at least one orthopteran. Observations of foraging individuals include a male feeding on a 30-mm caterpillar, an unsexed bird foraging on small fruits in a tree in the Manantantely Forest, and an adult dispatching a praying mantid in the Bealoka Forest. Feeding behavior often involves probing trees with cracked or convoluted bark, such as *Euphorbia tirucalli*, *Fernandoa madagascariensis*, and *Tamarindus*.

BREEDING—A pair taken at Manafiafy on 10 October consisted of an adult male with gray testes 7×4 mm and an adult female with an ovary 7×6 mm and with no greatly enlarged ovarian follicles. A female obtained on 28 September in the Manantantely Forest had an enlarged ovary, a partially shelled egg in the oviduct, and two corpora lutea.

On 17 November at 1200 m in parcel 1 of the RNI d'Andohahela, a male and a female were displaying to each other. The display consisted of a rapid series of short wing flicks, either a single wing or both wings together, while the birds gave a repeated quiet whistle. In the same reserve, a male and a female shared duties at a nest at 1650

TABLE 5. Number of *Phyllastrephus madagascariensis*, *P. zosterops*, and *P. cinereiceps* netted at humid forest sites.

Site, Elevation	No. of accrued net- days	P.		
		<i>madagas- cariensis</i>	<i>P. zosterops</i>	<i>P. ciner- eiceps</i>
Analalava				
40 m	31	11	2	0
Marosohy	425 m	50	7	3
	725 m	63	4	12
Marovony				
50 m	110	16	0	0
Manantantely				
100 m	32	7	0	0
Andohahela				
440 m	50	8	4	0
810 m	50	1	3	0
1200 m	50	3	7	1
1500 m	50	0	0	4
1875 m	50	0	0	0

m in late November. The nest was a shallow cup made of flaky lichens, held together with spider web, with a lining made of moss. It was situated on a 10-cm-diameter horizontal branch about 7 m above the ground.

WEIGHT—Combined (6), 47.0 ± 2.9 (42.5–51.0) g.

SOFT PART COLORS—Bill, legs, and claws: black; iris: dark brown.

LOCAL NAMES—*Bokazava* (Manantantely), *bokazavo* (Manombo), *mavoloha* (Berenty), *tsirikiti* (Berenty).

Pyconotidae

Phyllastrephus madagascariensis *madagascariensis*

Long-billed Greenbul

This species was found in humid forests from the Marovony Forest south through the Anosyenne and Vohimena ranges to Manantantely between 50 and 1200 m. During the 1995 inventory of parcel 1 of the RNI d'Andohahela, this species was found between 440 and 1200 m, although it was markedly less common at 1200 m than at lower elevations (Table 5). At 1200 m it was found only in valleys where the vegetation resem-

bled that of lower elevations. Appert (1985) reported it from the Bemangidy Forest. It was not recorded in heavily disturbed forested areas or in littoral forest. All material examined from the region is referable to the nominate subspecies. There is an unsubstantiated report of this species in the Ankoba Forest, near the RP de Berenty (Rakotondranony, 1977); this forest is primarily a monoculture of *Pithecellobium dulce*, and without further details this record cannot be accepted.

DIET—Stomachs examined contained spiders (Araneae), Diplopoda, Blattodea, Coleoptera (Chrysomelidae, Cleridae, Curculionidae, Elateridae, Tenebrionidae), Homoptera (Cicadellidae, Cicadidae, Fulgoroidea), Hymenoptera (Formicidae), Orthoptera, and Reptilia (Gekkonidae) (Goodman & Parrillo, in press).

BREEDING—Specimens taken in the Analalava Forest between 5 and 10 November were mostly adults in reproductive condition. Adult males lacked or had indistinct brood patches, whereas adult females often had well-defined or vascularized brood patches. The only nonadult taken during this period was a bird with a totally unossified skull and a 3-mm bursa. Seven birds captured in the Manantantely Forest between 30 September and 2 October, 11 birds handled in the Marosohy Forest between 29 November and 11 December, and 15 birds netted in the Marovony Forest between 26 October and 3 November were all adults. On 27 December in the RNI d'Andohahela (parcel 1) at about 900 m we saw an adult feeding two fledglings, and at about 950 m we saw two immatures unaccompanied by adults.

WEIGHT—Female (12), 25.4 ± 2.7 (22.0–31.5) g; male (15), 32.0 ± 4.3 (22–39) g; combined (56), 30.8 ± 4.4 (22–39) g.

SOFT PART COLORS—Bill: maxilla dark gray or dark brown and in subadults dusky, and mandible (highly variable) horn gray at base merging to dark brown tip, dull pinkish brown or pale gray brown with dusky tip and in subadults medium brown and medially yellowish brown; mouth lining: yellow; legs: grayish brown or brown and sometimes with orange tinge; foot pads: ochre yellow; claws: gray; iris: medium brown to dark brown and in subadults gray brown.

LOCAL NAMES—*Parataky* (Marosohy), *pretaka* (Marovony), *pretaky* (Manombo).

Phyllastrephus zosterops zosterops Spectacled Greenbul

The Spectacled Greenbul was relatively common in the closed-canopy humid forests of Ma-

rosohy, Analalava, and Manantantely. This species also was found in various areas of the RNI d'Andohahela (parcel 1) between 440 and 1200 m elevation; it was much less common at 1200 m than at lower altitudes (Table 5). It also was recorded in transitional forest north of Trafonaomby between 1500 and 1700 m. At all of these localities except the last it was sympatric with *P. madagascariensis*. At a few sites with apparently similar forest types (e.g., Marovony and Manantantely forests), however, *madagascariensis* was relatively common and *zosterops* was absent. *P. zosterops* was not recorded in littoral forest. All specimens examined from the region are referable to the nominate form.

DIET—The stomach contents of collected birds contained spiders (Araneae), beetles (Curculionidae, Elateridae, Hydrophilidae, Scarabaeidae, Staphylinidae, Tenebrionidae), Dermaptera, Isoptera, flies (Nematocera), Homoptera, ants (Formicidae), and Orthoptera (Tetrigidae) (Goodman & Parrillo, in press).

BREEDING—Most of the individuals collected in the Analalava and Marosohy forests between early November and mid-December were adults in reproductive condition, including males with testes up to 11×7 mm and females with enlarged ovaries and ovarian follicles up to 9 mm in diameter. Males apparently lack brood patches.

Many nests and fledged juveniles of this species were found in parcel 1 of the RNI d'Andohahela between 18 October and 6 November. All nests were deep cups, suspended between the branches of understory shrubs or, in one case, 2 m above the ground in a *Diospyros* sapling. Nests with two fledglings, in each case estimated to be 2 or 3 days old, were found at 440 m (one nest) and 810 m (two nests). At 440 m, seven groups of adults feeding juveniles were seen: four with one juvenile, one with two, and one with three. In two cases, three adults were feeding the juveniles. The extra individual in each case may have been a "helper." Apparent helpers also have been noted in *P. cinereiceps* (see below; also Hawkins et al., in press). On 29 November a pair of adults was feeding two newly fledged juveniles in transitional forest at 1700 m, north of Trafonaomby.

WEIGHT—Female (5), 17.7 ± 2.9 (15.5–22.5) g; male (6), 19.0 ± 1.0 (18.5–20.5) g; combined (35), 18.3 ± 1.8 (13.5–22.5) g.

SOFT PART COLORS—Bill: maxilla brown with yellow cutting edge or completely black, and mandible yellow or orangish yellow sometimes

with brown tip; mouth lining: bright yellow; legs: grayish pink, grayish brown, or grayish yellow; foot pads: yellow; claws: pinkish gray or gray; iris: brown.

Phyllastrephus cinereiceps Gray-crowned Greenbul

The Gray-crowned Greenbul has been recorded in southeastern Madagascar only in the humid forest of the RNI d'Andohahela between 810 and 1950 m. At 810 m this species was only found in a small area with elements of upper montane forest. At higher elevations it was more common, although less so above 1850 m in low mossy forest near the summit of Trafonaomby (Table 5). It appeared to be absent from the transitional forest between 1500 and 1700 m north of Trafonaomby.

BREEDING—On 13 November at 1200 m, three adults were feeding two recently fledged juveniles. The fledglings were dull gray-green above, the same color on the crown, and dull buffy underneath with a slightly paler throat. At 1650 m on 21 November, two adults were seen with two juveniles. These fledglings were older than those seen at 1200 m and had uniform gray-green upperparts with a slight gray tinge to the crown feathers, pale orange gapes, and slightly yellow-tinged underparts and were paler, almost whitish, on the throat. On 4 December at 1900 m, three adults were accompanying two juveniles. These juveniles appeared to be molting into adult plumage, with grayish brown caps contrasting slightly with olive brown backs and blotchy whitish throats contrasting with yellow breast and belly.

WEIGHT—Male (1), 18.5 g; combined (4), 17.1 \pm 1.1 (16.0–18.5) g.

SOFT PART COLORS—Bill: maxilla black with gray cutting edge, and mandible dark pinkish gray at base merging to black tip; legs: pinkish gray; iris: brown.

Hypsipetes madagascariensis madagascariensis Madagascar Bulbul

The Madagascar Bulbul was one of the most common and widespread birds in the humid and littoral forests of southeastern Madagascar from sea level to 1500 m. This species was found at every site we visited from the Marovony Forest south through the Anosyenne and Vohimena

mountains and along the coastal plain to the Petriky Forest and west to the Mandrare River. It occurs in open habitats, particularly in heavily disturbed areas such as grasslands and agricultural fields with scattered trees, and at the forest edge, as well as in the heart of intact forests. West of the Anosyenne Mountains, in spiny forest, it was not as abundant, although even in this region it was common in relatively intact and disturbed spiny forest and gallery forest and along river margins.

DIET—Food remains in the stomachs of collected individuals consisted of fruits (small *Ficus*), small seeds, spiders (Araneae), beetles (Cuculionidae, Elateridae, Scarabaeidae: Hopliini), and Hemiptera (Reduviidae) (Goodman & Parrillo, in press). They have been noted dispatching and feeding on large spiders such as *Nephila*. Madagascar Bulbs have been observed feeding on fruits of *Capparis* spp., *Rinoria greveana*, *Neotina isoneura*, *Cordia ronnii*, and *Celtis philippensis* and on the flowers of *Crateva excelsa*. This bulbul is able to exploit a variety of ornamental plants in remote and isolated villages away from the forest such as Vohibaka (800 m) on the northern limit of RNI d'Andohahela (parcel 1), where it feeds extensively on the berries of introduced *Melia azedarach*.

BREEDING—All Madagascar Bulbs collected during the QIT project were adult, and the vast majority were in or approaching breeding condition. All males lacked brood patches. A nest with three eggs was found on 9 November at the edge of the Analalava Forest. The nest was placed in a tree about 3.5 m above the ground and secured to four points of two adjacent branches with spider web. On 15 October in the Manafiafy Forest an adult was observed feeding two fledglings. On 28 November and 2 December, at different localities in the Marosohy Forest, adults were observed bringing food to nests or feeding fledglings. In the latter case, one adult of the pair had a large beetle in its beak and the other had a large moth, the wings of which it tore off.

WEIGHT—Female (7), 43.6 \pm 5.8 (33–52) g; male (14), 44.3 \pm 3.4 (39–52) g; combined (38), 44.9 \pm 4.0 (33–52) g.

SOFT PART COLORS—Bill: maxilla orange often with dusky tip and occasionally with dusky nasal operculum, and mandible orange; legs: dull orangish brown or dull yellowish orange; claws: grayish brown or black; iris: reddish brown.

LOCAL NAMES—*Horova* or *horovana* (Man-

ombo, Marosohy), *tsikonina* (Berenty), *tsikorova* (Manantantely).

Turdidae

Copsychus albospecularis pica and *Copsychus albospecularis inexpectatus*

Madagascar Magpie Robin

The Madagascar Magpie Robin was found from the Marovony Forest south through the Anosyenne and Vohimena mountains to Petriky and west to the Mandrare River. This species was common in a variety of habitats, including closed-canopy humid forest, littoral forest, secondary natural forest, degraded areas along the forest edge, gardens in Tolagnaro, eucalyptus plantations, intact and degraded spiny forest, and gallery forest between near sea level and 1200 m. During the 1995 inventory of parcel 1 of the RNI d'Andohahela, it was found only in the 440 m, 800 m, and 1200 m elevation zones, where it was rare as compared with its distribution in similar habitats elsewhere on the island. Although this species was generally common in littoral forest, we did not find it at Mandena, and it was rare at Petriky. *Copsychus* also was not found at the Station Forestière de Mandena during a survey in the 1960s or 1970s (GR).

The distributions of *Copsychus a. inexpectatus* and *C. a. pica* were sharply defined in this region. Specimens (AMNH, FMNH) obtained west of the Anosyenne Mountains, in spiny forest, are all referable to *pica*, as are specimens from the littoral forest of Petriky. Those to the east, in humid and littoral forest areas, are *inexpectatus*, including birds taken in the forests of Marovony, Analalava, Manafiafy, Bezavona, and Manantantely (FMNH) and 30 km NNW Fort-Dauphin (MNHN). The distance between the populations of *C. a. pica* at Petriky and *C. a. inexpectatus* at Manantantely is less than 8 km (by air).

DIET—The stomachs of specimens collected 30 km NNW Fort-Dauphin (MNHN) contained insects and spiders. The stomach contents of our collected material included Isopoda, Blattodea, spiders (Araneae), Orthoptera, Hemiptera (cf. Aradidae), adult beetles (Acanthoceridae, Carabidae, Cucujidae, Curculionidae, Elateridae, Scarabaeidae, Staphylinidae, Tenebrionidae), beetle larvae, ants (Formicidae), plant fibers, and small amphibians and geckos (Goodman & Parrillo, in press). In the Ankapoky Forest a mixed-species group was ob-

served in a *Dicoma*; a male magpie robin and two *Ploceus sakalava* were eating blossoms, and *Nectarinia notata* and *N. souimanga* were feeding on the contents of flowers. *C. albospecularis* also has been observed feeding on fruits and berries.

BREEDING—Most adults collected during the 1989–1990 field seasons between late September and late December had enlarged gonads. A female obtained in the Analalava Forest on 5 November had an unshelled egg in oviduct, two corpora lutea, and an ovarian follicle 8 × 7 mm. Fledglings and subadults were noted in the RNI d'Andohahela (parcel 1) at 1200 m on 16 November being fed by adult males, in the Bezavona Forest on 29 December, in the Marosohy Forest on 3 and 12 December, and in the Manafiafy Forest on 19 and 20 December.

The 12 December fledgling had been captured by an *Accipiter madagascariensis*; the Tandroy people around Bealoka noted this raptor feeds extensively on *Copsychus*. No adult male in breeding condition was found with a brood patch.

WEIGHT—*C. a. inexpectatus* female (22), 23.7 ± 2.8 (18.5–30.5) g; male (27), 24.9 ± 1.7 (20.0–28.5) g. *C. a. pica* female (1), 18.5 g; male (1), 19.5 g. *C. a. inexpectatus* and *pica* combined (59), 24.2 ± 2.7 (16.5–30.5) g.

SOFT PART COLORS—Bill: black; mouth lining: dull orangish yellow (fledgling); legs: olive brown, light gray, or black; claws: light gray or black; iris: brown. *C. a. pica* tends to have much darker legs than does *C. a. inexpectatus*.

LOCAL NAMES—*Fitatra* (Manafiafy), *fitatr'ala* (Manafiafy), *fitatry* (Marosohy), *peeda* (Berenty), *tsilaka* (Manombo).

Saxicola torquata sibilla

Stonechat

The Stonechat was found in southeastern Madagascar from the Marovony Forest south through the Anosyenne and Vohimena mountains, to Petriky and west through the spiny forest to the Mandrare River between near sea level and 1900 m. This species was distinctly rarer in drier portions of its distribution. Throughout this range it is found in open areas (often degraded), such as grassland and heathland, or at the edge of lakes and lagoons, often perched on bushes or small rocky outcrops. We never observed it in any type of natural humid forest. In the transitional forest north of Trafonaomby between 1500 and 1800 m, at least seven different pairs were located in hab-

itats ranging from edges of dense forest to open burnt grassland adjacent to a marsh. This species clearly has benefited from human-induced habitat modifications. We have few records of this species in spiny forest; one bird was observed near Bealoka along the river floodplain. Specimens examined from the area are referable to *S. t. sibilla*.

DIET—The stomachs of collected individuals contained spiders (Araneae), Blattodea, Coleoptera (Scarabaeidae, Tenebrionidae), Hymenoptera (Formicidae), and Orthoptera (Gryllacrididae) (Goodman & Parrillo, in press).

BREEDING—On 13 October at Manafiafy a pair of adults was collected with two fledglings. North of Trafonaomby, between 1500 and 1800 m, many pairs of Stonechats had fledged juveniles in late November and early December.

WEIGHT—Female (1), 16.5 g; male (1), 15.0 g.

SOFT PART COLORS—Bill: black in males, dark brown in females, and gray in fledglings; legs: black or dark brown; claws: black; iris: brown.

LOCAL NAME—*Fitadroanga* (Manafiafy).

Pseudocossyphus sharpei sharpei

Forest Rock-Thrush

The Forest Rock-Thrush was recorded in the Marosohy and Marosalohy forests and parcel 1 of the RNI d'Andohahela, where it was observed in intact closed-canopy humid forest between 1100 and 1875 m. This species also was observed between 1500 and 1800 m in the transitional forest north of Trafonaomby. At this locality they frequently foraged at the edge of the forest, up to 50 m from closed forest. Langrand (1990) reported this species from areas as far south as Tolagnaro at elevations above 810 m. The form occurring in the area is nominate *sharpei*.

BREEDING—Adult males collected in early November had enlarged testes (maximum size: left, 9 × 5 mm; right, 7 × 4 mm) and did not possess brood patches. On 1 November at 1235 m in the Marosalohy Forest we saw an adult female carrying nesting material. Within parcel 1 of the RNI d'Andohahela at 1200 m on 19 November, a male was seen carrying food, presumably for juveniles, and on 21 November a male and female were seen in the company of two juveniles. At 1500–1800 m in transitional forest north of Trafonaomby between 27 November and 3 December three different pairs were located with two, one, and one juveniles, and a fledgling was netted at 1875 m on 29 November, below the summit of Trafon-

aomby. The juveniles were in subadult plumage with short tails and wings, and all back and head feathers had paler tips. The breast feathers had wider pale tips. None of the wing feathers were tipped paler except the innermost greater coverts and very fine edges to the remiges.

SOFT PART COLORS—Bill: black; mouth lining: yellow; legs: pinkish gray; feet: dull yellow; claws: black; iris: brown. In the fledgling the maxilla was black around nasal operculum merging to gray tip and dull yellow cutting edge and the mandible was dull yellow.

WEIGHT—Male (6), 24.0 ± 1.4 (22.5–25.5) g; fledglings (2), 24.5, 24.5 g.

Pseudocossyphus imerinus

Littoral Rock-Thrush

We only have a single record of this species in southeastern Madagascar. We saw two individuals on 24 December in an area of coastal dunes and sparse vegetation at Lac Anony, the eastern limit of this species' distribution (Langrand, 1990). Farkas's (1974) prediction that this species' range might extend to Tolagnaro has not been verified. However, what is apparently appropriate coastal xerophytic habitat for the Littoral Rock-Thrush exists along the sea south-southwest of Ranopiso, and this species may occur in that area.

Sylviidae

Acrocephalus newtoni

Madagascar Swamp-Warbler

Although this species is widespread across Madagascar (Langrand, 1990), we have few records of the Madagascar Swamp-Warbler from southeastern Madagascar, despite permanent reed beds in the region that appear to have suitable habitat for this species. It has been observed near Sainady, 5 km north of Tolagnaro, at several sites along the Mandrare and Mananara rivers, along the Ranopiso River, and in the reed beds along the Tarantsy River near Bevilany.

Cryptosylvicola randrianasoloi

Cryptic Warbler

The recently described (Goodman et al., 1996) Cryptic Warbler is known in southeastern Mada-

gascar only from the RNI d'Andohahela (parcel 1), where it was recorded between 810 and 1900 m. This species was most common in the 1200 and 1500 m zones and was distinctly rare at 810 m.

DIET—On 9 November at 1200 m, a *C. randrianasoloi* captured a 1.5-cm-long cricket from a leaf about 3 m off the ground, with which it flew to the ground. The cricket was beaten on the ground for 2 minutes before being eaten; the legs were eaten separately.

BREEDING—An individual was observed on 9 November at 1200 m carrying food, presumably for juveniles. On 21 November at 810 m, a mixed-species flock contained a group of six *C. randrianasoloi*, including three juveniles.

LOCAL NAME—*Simitsy* (RNI d'Andohahela, parcel 1).

Nesillas lantzii

Lantz's Brush-Warbler

Recent work on the relationships of *Nesillas* in southeastern Madagascar has found that the spiny forest and littoral forest form *N. (typica) lantzii* is genetically isolated from the humid forest populations (*N. t. typica*) and that the two should be considered separate species (Schulenberg et al., 1993). Here we propose the English common name Lantz's Brush-Warbler for this species.

N. lantzii occurs in the spiny forest, east over the Col de Ranopiso to Petriky and Tolagnaro (FMNH), and then north through the littoral forest zone to perhaps Mandena (sight records). Presumably *lantzii* is the form occurring west to the Mandrare River, although it is not particularly common in the forest habitat of Malaza and Bealoka. In mid-December this species was not found in gallery and spiny forest of parcel 2 of the RNI d'Andohahela east of Hazofotsy.

Lantz's Brush-Warbler is a common bird in intact to heavily disturbed littoral forest and spiny forest from sea level to about 100 m. This species can also be found in low scrub and village gardens (e.g., Tolagnaro) and in relict humid forest patches at Pic St. Louis (near Tolagnaro). It typically forages close to the ground, skulks in relatively thick vegetation, and makes its presence known by its characteristic rattling contact call.

DIET—Stomach contents of collected individuals invariably contained insect remains.

BREEDING—None of the specimens we obtained in September and October were in or approaching breeding condition.

WEIGHT—Female (1), 15.0 g; male (5), 17.4 \pm 0.8 (16.0–18.0) g; combined (6), 17.2 \pm 0.9 (15.0–18.0) g.

SOFT PART COLORS—Bill: maxilla dusky gray or black with yellow cutting edge, and mandible yellowish gray or light pinkish yellow with darker subterminal spot; mouth lining: yellow; legs: dull bluish gray; claws: black; iris: medium brown.

Nesillas typica typica

Madagascar Brush-Warbler

The range of the Madagascar Brush-Warbler in southeastern Madagascar is from the Marovony Forest south through the humid forests of the Anosyenne and Vohimena mountains to the Manantantely Forest from near sea level to 1900 m. It also occurs in littoral forest as far south as Manafiasy (Schulenberg et al., 1993). Throughout this area it is parapatric with *N. lantzii*. In the heart of the Marosohy Forest the Madagascar Brush-Warbler was distinctly more common in scrubby areas along river margins and regenerating areas associated with natural landslides than in closed-canopy forest. In parcel 1 of the RNI d'Andohahela, this species was absent from humid forest at 440 m, scarce at 810 m, and abundant at 1200–1900 m. This pattern has been noted in other humid forests (Hawkins et al., in press). In contrast, outside of humid forest, in degraded areas and secondary forest, the species is common at much lower elevations.

DIET—The stomachs of three individuals contained spiders (Araneae), Diplopoda, Blattodea, Coleoptera (Nitidulidae, Tenebrionidae), Hemiptera, Homoptera, and Hymenoptera (Apoidea) (Goodman & Parrillo, in press).

BREEDING—Two males taken in the Marovony Forest in late October had testes up to 12 \times 8 mm. A recent fledgling, still being fed by its parents, was found in scrub at the edge of the Analalava Forest on 5 November.

WEIGHT—Female (3), 16.0, 16.5, 18.5 g; male (6), 18.4 \pm 1.9 (17.0–22.0) g; combined (25), 18.6 \pm 2.4 (15.0–26.0) g.

SOFT PART COLORS—Bill: maxilla dusky gray or black with yellow cutting edge, and mandible yellowish gray or light pinkish yellow; mouth lining: yellow; legs: pale grayish brown or dull bluish gray; claws: brown; iris: medium brown and grayish brown (subadults).

LOCAL NAME—*Parataka*.

Thamnornis chloropetoides

Thamnornis Warbler

The eastern boundary of this dry country species extends into the western limit of southeastern Madagascar as it is defined herein. Langrand (1990) reported this species from the RP de Berenty. In parcel 2 of the RNI d'Andohahela it was rather scarce. Only nine singing birds were located along 5 km of trail; this frequency is much lower than that in spiny forest in southwestern Madagascar. This species has been found in the *Euphorbia* bush scrub near Lac Anony and seems to be more common in coastal areas with appropriate habitat than in inland areas.

Cisticola cherina

Madagascar Cisticola

This species was found in open areas from the Marovony Forest south through the low hills of the Anosyenne and Vohimena mountains to Petrikely and west to the Mandrare River, from sea level to about 1500 m. It was particularly common along the coastal plain in low-lying areas of heathland, wet grassland, rice paddies, marshes, and meadows. Along the lower slopes of the mountains this species generally was confined to agricultural fields, although we did find it in grassland areas at 800 m near Antseva and at 1500 m in a seasonal marsh north of Trafonaomby. West of the Anosyenne Mountains it was locally common along grass verges and undisturbed grassland pastures and in gallery and riverine habitat. In the RP de Berenty, it was common in the meadow bordering the inland limit of the gallery forest.

BREEDING—An adult female netted at Ankapoky on 9 October was not in breeding condition.

WEIGHT—Unsexed (1), 9.7 g.

SOFT PART COLORS—Bill: maxilla black with gray cutting edge, and mandible gray; legs: grayish pink; iris: tan brown.

Dromaeocercus brunneus

Brown Emutail

The Brown Emutail is known in southeastern Madagascar only from the upper montane zone of the RNI d'Andohahela (parcel 1) between 1200 and 1800 m. In this zone it was fairly common in the understory of forested areas with dense herbaceous cover.

Randia pseudozosterops

Rand's Warbler

All of our records of Rand's Warbler in southeastern Madagascar are from the humid forests of Marosohy, Marosalohy, and parcel 1 of the RNI d'Andohahela. In these forests, which are more or less contiguous, it was observed in undisturbed forest between 375 and 1600 m. Most of our records are of single individuals 20–25 m high in closed-canopy forest, often singing from the crowns of tall riverside trees. At elevations above 800 m this species is distinctly less common. On several occasions it was observed in mixed-species foraging flocks. This species characteristically forages along horizontal branches, hitching along the surface of the branch and often peering under to check the undersurface of the branches.

No specimens of this species are known from southeastern Madagascar. The previous southernmost record was the humid forest in the RNI d'Andringitra (Goodman & Putnam, 1996).

BREEDING—On 26 November at 1500 m in parcel 1 of the RNI d'Andohahela, two adults were feeding a begging juvenile in the middle of a multispecies flock. The juvenile appeared similar in plumage pattern and coloration to an adult.

Newtonia amphichroa

Dark Newtonia

In southeastern Madagascar the Dark Newtonia inhabits areas of intact humid forest from the Marovony Forest south through the Anosyenne and Vohimena ranges to the forests of Bezavona and Marosohy and portions of parcel 1 of the RNI d'Andohahela from above 440 m to about 1900 m. At this latter site it was absent from forest at about 440 m, most common between 810 and 1500 m, and still fairly common at 1900 m. It was not recorded in the transitional forest north of Trafonaomby between 1500 and 1700 m. A specimen was collected 30 km NNW Fort-Dauphin (MNHN). This species has not been recorded in the Manantantely Forest or in any littoral forest.

Juveniles of *N. amphichroa* are different from juveniles of *N. brunneicauda* in that individuals of the former species are distinctly darker and the edges of the upper wing coverts are broadly edged with reddish brown (FMNH).

DIET—The stomachs of two specimens collected in 1989 contained spiders (Araneae: Salticidae), beetles (Chrysomelidae, Curculionidae),

ants (Formicidae), Homoptera, and Orthoptera (Goodman & Parrillo, in press).

BREEDING—A fledgling being fed by an adult was noted in the Marosohy Forest on 25 November at about 1100 m. A similar observation was made in parcel 1 of the RNI d'Andohahela on 25 November at 1500 m.

WEIGHT—Male (2), 12.0, 12.5 g; combined (13), 12.5 ± 1.5 (10.0–15.5) g; subadult (3), 9.5, 10.5, 10.5 g.

SOFT PART COLORS—Bill: black or dark brown; mouth lining: yellow; legs and claws: gray; iris: golden yellow (adult) and brownish gray (subadults).

Newtonia brunneicauda brunneicauda Common Newtonia

This species was the most common and widespread of the four *Newtonia* spp. in southeastern Madagascar. It was noted in humid, littoral, transitional, and spiny forest from Marovony Forest south through the Anosyenne and Vohimena ranges to Petriky and west to the Mandrare River. It occurs in primary to heavily disturbed forests and at the forest edge from near sea level to 1900 m. It was recorded in virtually every forest parcel visited in the region. The sole exception is the Mandena Forest; however, there is a specimen taken 7 km north of Tolagnaro (MNHN), which would be in or close to the Mandena Forest. This species previously has been reported from the Be-mangidy Forest (Appert, 1985). Together with *Neomixis tenella* and *Nectarinia souimanga*, it was one of the most common small passerines in littoral forest.

In spiny forest the Common Newtonia was relatively common in the lower strata of the spiny forest, generally below 5 m. In this habitat *N. brunneicauda* is broadly sympatric with *N. archboldi*. The Common Newtonia is also found in gallery forest, e.g., RP de Berenty. All specimens examined from southeastern Madagascar are referable to *N. b. brunneicauda*.

DIET—The stomachs of collected specimens contained spiders (Salticidae), Blattodea, beetles (Anobiidae, Buprestidae, Chrysomelidae, Cleridae, Curculionidae, Elateridae, Scarabaeidae), Hemiptera, Homoptera (Cicadellidae), Diptera, Hymenoptera (Formicidae), and Lepidoptera (larvae and adults) (Goodman & Parrillo, in press). An adult taken near Mandena had been feeding on insects similar to small cicadas (MNHN). In subarid

regions this species was regularly observed feeding in flowering *Euphorbia* and *Sarcostemma*. The birds may be exploiting insects attracted to the nectary glands of the former and to the pungent, fragrant flowers of the latter.

BREEDING—The vast majority of adult *brunneicauda* specimens taken in the area between late September and late December were not in breeding condition. In the RNI d'Andohahela (parcel 1) no evidence of this species breeding was found between mid-October and early December. Fledglings were found at Manafay on 10 and 24 October. In the Ankapoky Forest, however, five adults collected during the first portion of October were in or approaching breeding condition. Thus, it is possible that the breeding of *brunneicauda* in southeastern Madagascar may be much earlier in the humid forest areas than in the dry forest areas.

WEIGHT—Female (8), 10.9 ± 0.7 (9.8–12.0) g; male (10), 10.5 ± 1.1 (8.9–12.5) g; combined (29), 10.4 ± 1.0 (8.7–12.5) g.

SOFT PART COLORS—Bill: black; mouth lining: yellow; legs: light pinkish brown or grayish brown; claws: gray; iris: pale dull yellow, pale cream, golden yellow, or dark brownish gray (subadults). One bird with a skull about 25% ossified had a pale yellowish brown iris, and another with an 80% ossified skull had a dull yellow iris.

LOCAL NAMES—*Andreabokia* (Berenty), *tsimimity* or *tsimimitsy* (Marosohy).

Newtonia archboldi Archbold's Newtonia

In southeastern Madagascar Archbold's Newtonia is confined to the spiny forest region, where it is relatively common in spiny forest. The eastern limit of this species's range is a few kilometers west of the eastern boundary of parcel 1 of the RNI d'Andohahela, south to the Col de Ranopiso. It occurs in appropriate habitat from the Ankapoky Forest west to the Mandrare River. It is particularly common in areas dominated by *Euphorbia* and *Didiereaceae*.

DIET—The stomachs of two collected individuals contained spiders (Araneae), beetles, Homoptera (Cicadellidae), Isoptera, and Lepidoptera (Goodman & Parrillo, in press).

BREEDING—An adult male taken at Ankapoky on 9 October had testes 5×4 mm (left) and 4×3 mm (right).

WEIGHT—Male (2), 7.2, 8.3 g.

SOFT PART COLORS—Bill, legs, and claws: black; iris: yellowish white.

Newtonia fanovanae Red-tailed Newtonia

Until 1989 the Red-tailed Newtonia was known only from the type specimen collected in 1931 in the Fanovana Forest, central eastern Madagascar (Gyldenstolpe, 1933). This species was found in November and December 1989 and May 1990 in the Marosohy Forest between 300 and 1300 m (Goodman & Schulenberg, 1991) and in late December 1992 in the adjacent forest of parcel 1 of the RNI d'Andohahela on the east side of the Col d'Ambatomanaha along the Isedro Trail at approximately 525 m. It also was observed on 22 July 1992 at 200 m elevation along the Tanatana Trail, in the same portion of the reserve (Langrand & Sinclair, 1994). In the RNI d'Andohahela (parcel 1) this species was recorded only at 440 m, where it was relatively common.

In southeastern Madagascar *N. fanovanae* is restricted to closed canopy forest, and it occurs sympatrically with two other species of *Newtonia*. These species show habitat and elevational segregation: *amphichroa* is restricted to montane forest and lives in the lower strata of forest between 810 and 1900 m; *brunneicauda* is the most widespread and occurs in the lower and middle strata of the forest between sea level and 1950 m; and *fanovanae* occurs in the middle and upper strata from 300 to 1375 m (see Goodman & Schulenberg, 1991, for further details).

DIET—The stomach of one bird was mostly empty but contained a few insect parts, presumably orthopteran.

BREEDING—An adult male specimen collected on 8 December had testes 10×5 mm (left) and 8×4 mm (right).

WEIGHT—Male (1), 12.5 g.

SOFT PART COLORS—Bill: maxilla black, and mandible horn gray at base merging to light gray at tip; mouth lining: horn gray; legs: slate gray; claws: light gray; iris: reddish brown.

Neomixis tenella Common Jery

In southeastern Madagascar the Common Jery was common in intact to heavily disturbed littoral and humid forest from Marovony south through

the Anosyenne and Vohimena mountains to Petriky. In this area it was regularly noted from near sea level to 150 m but was rarer at higher elevations up to 1700 m. In the Marosohy Forest it was sympatric with *N. viridis* and *N. striatigula*. In the humid forest of parcel 1 of the RNI d'Andohahela this species was most common at 440 m and 810 m, rarer at 1200 m, and completely absent above 1500 m. However, it reappeared in transitional forest north of Trafonaomby, at elevations from 1500 to 1700 m. This species often was found in the ecotone of secondary littoral forest and heathland or grassland areas, where it was one of the most common birds, e.g., near the forests of Manafay, Mandena, Itapera, and Petriky. It also was a garden bird of coastal towns and villages, including Tolagnaro. In this region the local subspecies is *N. t. orientalis*, as is a specimen taken near Lac Anony (PBZT).

The Common Jery was distinctly less common in the spiny forest region west of the Anosyenne Mountains. In this area it was found in spiny forest, often sympatric with *N. striatigula*, and in gallery forest, for example along the Mandrare River. The form occurring in this region is presumably *N. t. debilis*.

This species was often noted foraging in small groups, both in single-species flocks of up to 15 individuals and in mixed-species flocks.

The juveniles observed in parcel 2 of the RNI d'Andohahela were brighter than the adults, with clean pale yellow breasts lacking the olive suffusion and streaking of the adults, orange gapes, and clean gray napes; they thus resembled adults of the race *N. t. tenella*, except that they had dark brown instead of pale irides. The adults had clear yellow throats and were heavily tinged olive on the sides of the breasts and narrowly streaked dark olive in the center. The crown was greenish yellow, the back was fairly bright greenish, and the nape was dull greenish gray. The legs were bright pale pink and the lower mandible of the bill was pale pinkish orange and the upper mandible was dark horn.

DIET—The stomachs of collected individuals contained arthropods, including spiders (Araneae: Salticidae), Blattodea, beetles (Chrysomelidae, Coccinellidae, Curculionidae, Scarabaeidae, Scolytidae), Diptera (Nematocera), Homoptera, Hymenoptera (Formicidae), Orthoptera (Gryllidae), and Lepidoptera (larvae and adults) (Goodman & Parrillo, in press). This species has been observed in Tolagnaro feeding at domestic *Hibiscus* flowers and at Bealoka at *Capparis* flowers. It is often

seen searching for insect larvae on the undersides of leaves, but it also will take adult insects (i.e., lacewings, which are easy prey). In dry areas they also visit the flowering heads of sisal and apparently prefer to search for food in vines and trees with compound leaves, *Acacia rovumae* being the most favored.

BREEDING—Numerous adults collected in littoral forest areas between mid-September and late October had enlarged gonads, including males with testes up to 9×6 mm and females with ovaries 7×2 mm and ova up to 1 mm in diameter. Fledglings and subadults were noticed at Manafiafy in mid- to late October and at Analalava on 9 November. An adult pair in parcel 2 of the RNI d'Andohahela on 12 December was accompanied by two well-grown juveniles. Males in breeding condition lacked brood patches. In subarid areas active nests have been found in November and fledglings have been found in mid-December.

WEIGHT—Female (2), 7.0, 8.5 g; male (11), 7.2 \pm 0.5 (6.8–8.2) g; combined (21), 7.3 \pm 0.5 (6.8–8.5) g.

SOFT PART COLORS—Bill: maxilla dark gray to black, and mandible dull pink sometimes with dusky tip and yellowish pink in fledglings; legs: light orangish brown; claws: gray or blackish gray; iris: light to medium brown.

LOCAL NAMES—*tsimimitraka* (Marosohy), *tsimitsy* (Berenty, Bealoka), *zea-zea* (Manafiafy), which is generic for *Neomixis* or perhaps small bird.

Neomixis viridis Green Jery

The Green Jery was uncommon and confined to intact humid forest parcels. We observed this species in the Marosohy Forest and parcel 1 of the RNI d'Andohahela between 350 and 1950 m and in the Bezavona Forest at about 75 m. In the RNI d'Andohahela it was present at all elevations from 440 to 1950 m but was most common at 810 and 1200 m and was distinctly scarce at 440 m. Langrand (1990) reported this species as occurring as far south as Tolagnaro. No specimens from the region are available, but presumably the local form is *N. v. viridis*.

BREEDING—On 2 November at 810 m in parcel 1 of RNI d'Andohahela, a group of three birds included a food-begging juvenile. The plumage of the juvenile was similar to that of the adult.

Neomixis striatigula pallidior and *Neomixis striatigula* [*striatigula*] Stripe-throated Jery

The Stripe-throated Jery was fairly common in intact humid forest at lower elevations (although recorded in montane forest at a few places) and more common in spiny forest. We found it in the Marovony Forest at approximately 50 m and in the Marosohy Forest and RNI d'Andohahela (parcel 1) between 440 and 1500 m. During an inventory of the latter forest, this species was present in all zones from 440 m to 1500 m but was much scarcer at and above 1200 m. Only odd individuals (easily detectable by their loud and persistent song) were found at 1200 and 1500 m. It also has been observed at about 1150 m in the forest east of Vohibaka in the extreme northwest corner of the RNI d'Andohahela, and it was common in transitional forest at 1500–1700 m, north of Trafonaomby.

Specimens are not available from the humid forest of the region, but we presume that this population is of *N. s. striatigula*. The distribution and southern limits of *N. s. sclateri* and *N. s. striatigula* are poorly defined (Salomonsen, 1934; Langrand, 1990).

In the spiny forest region it is common, seemingly more so than in humid forest or at least more conspicuous, often singing in the tallest substrate available in relatively open places. In this region it has been recorded at a wide range of spiny forest sites, e.g., near Ankapoky and Hazofotsy, near gallery forest and *Euphorbia* bush at Bealoka and Berenty, and along the Mandrare River. The subspecies occurring in the spiny forest is *N. s. pallidior* (FMNH). The individuals occurring in the transitional forest, being isolated from populations in humid forest, may belong to the subdesert subspecies *N. s. pallidior*.

DIET—The stomachs of two individuals collected in the Ankapoky Forest contained beetles (Curculionidae), Hemiptera, ants (Formicidae), and crickets (Gryllidae) (Goodman & Parrillo, in press).

BREEDING—Birds collected at Ankapoky in mid-October were in breeding condition. Adult males with large testes lacked brood patches.

WEIGHT—Combined (6), 8.6 \pm 0.6 (7.8–9.5) g.

SOFT PART COLORS—Bill: maxilla black or brownish black, and mandible gray at base merging to black tip; legs: grayish pink; claws: black; iris: orangish red or orangish brown.

Hartertula flavoviridis

Wedge-tailed Jery

In southeastern Madagascar the Wedge-tailed Jery was only recorded in the humid forests of Marosohy at about 425 m, in Bezavona at about 85 m, and in the RNI d'Andohahela (parcel 1) between 440 and 1500 m. At the latter site it was seen once at 440 m and was most common from 810 to 1200 m. In the Marosohy Forest this species was noted several times in multispecies flocks with *Phyllastrephus madagascariensis* and *P. zosterops*. It generally foraged and moved quickly in the lower and middle strata of closed-canopy forest.

DIET—The stomach of an individual obtained in the Marosohy Forest contained Dermaptera (Goodman & Parrillo, in press).

BREEDING—On 31 October at 810 m in parcel 1 of the RNI d'Andohahela, a family group consisting of a pair and two juveniles was seen. The juveniles resembled the adults except that the heads were uniform dull olive, the tails were short, and the underparts were dull green yellow. The fleshy gape was conspicuously yellow. Another group on 21 November at 1200 m consisted of two adults and three juveniles. These juveniles were older than those found on 31 October and were similar to the adults except that they had olive, not gray, ear coverts. A female collected in the Marosohy Forest on 11 December had 90% of the skull ossified and a nonenlarged ovary.

WEIGHT—Female (1), 9.4 g; combined (4), 9.4 ± 0.3 (9.2–9.8) g.

SOFT PART COLORS—Bill: maxilla black with gray cutting edge, and mandible gray with black spot as base and occasionally with black tip; legs: horn gray; feet: dull yellow or yellowish green; iris: brown.

LOCAL NAME—*Tsimimitrala* (Marosohy).

Monarchidae

Pseudobias wardi

Ward's Flycatcher

The only locality in southeastern Madagascar in which Ward's Flycatcher has been noted has been in the contiguous forests of Marosohy, Marosalohy, and the RNI d'Andohahela (parcel 1). In this area it has an elevational range between 440 and 1500 m but was most common between 810 and 1200 m. This species was often noted

perched in relatively open forested areas, generally at the edge of ravines, from where it would sally out and capture insects on the wing. Specimens in MNHN were collected 30 km NNW Fort-Dauphin.

DIET—The stomachs of two individuals collected 30 km NNW Fort-Dauphin on 28 May contained exclusively insect remains (MNHN).

BREEDING—An adult was observed carrying food, presumably for a juvenile, on 2 November at 810 m in parcel 1 of the RNI d'Andohahela. The testes of one of the specimens (MNHN) mentioned above were 1.7 × 0.7 mm (left) and 1.6 × 0.7 mm (right).

Terpsiphone mutata mutata

Madagascar Paradise Flycatcher

In southeastern Madagascar the Madagascar Paradise Flycatcher was noted from the Marovony Forest south through the Anosyenne and Vohimena mountains to Petriky and west across the spiny forest region to the Mandrare River, from near sea level to 1800 m. Although this species was common in a variety of forest habitats, it appeared to achieve its highest densities in secondary littoral or humid forest, such as portions of the Manafiafy Forest. It was recorded in virtually every littoral and humid forest site visited. In parcel 1 of the RNI d'Andohahela, this species was recorded at all elevations sampled below 1800 m, although it was most common between 440 and 810 m and rare at 1500 m. On a few occasions individuals were observed in gardens on the outskirts of Tolagnaro. A specimen was collected in 1756 near Fort-Dauphin (Stresemann, 1952).

In the spiny forest region it was distinctly less common than in more humid areas to the east, although it is broadly distributed across the spiny forest. In areas with gallery forest, such as along the Mandrare River, however, populations are dense. In the RP de Berenty a *Terpsiphone* was caught in the large webs of the colonial *Nephila* spider.

Adult males in definitive plumage exhibit considerable variation in coloration: the tail streamers and breast may be white or rufous, the throat and rectrices (other than the central pair) may be black or rufous, and the back may be black, white, or rufous. Certain combinations of plumage patterns occur sufficiently frequently that these have been interpreted as representing four discrete color phases. On the basis of the geographic distribution

of the frequency of color morphs, two subspecies have been recognized (Salomonsen, 1933a, b). We suspect that plumage variation in fact is more complex than Salomonsen realized and that the plumage sequences of this species are not well understood. Until the sequences of plumages and genetics of polymorphisms are better understood, we refrain from recognizing subspecies on Madagascar.

Yamagishi et al. (1992) noted that all fledglings (unsexed) in four nests, with both "white morph" (three nests) and "rufous morph" (one nest) males in attendance, were all rufous. From this they suggested that this species has delayed plumage maturation, and that "white morph" males are older than "rufous morph" birds. We have independent evidence of delayed plumage maturation in males (see below), but we are less convinced by their suggestion that the definitive "rufous morph" is a plumage that precedes acquisition of "white morph" plumage. It is surprising that such basic questions remain unanswered, because many of these questions could be addressed fairly easily with color-marked birds. R. Mulder is currently conducting genetic studies of a color-banded population in the RP de Berenty area, and over the next few seasons some of these questions should be answered.

We collected several rufous males in October and November that were in a plumage identical to that of the females, with brown wing coverts, no or very short rufous tail streamers, and pale reddish brown underparts. These males had fully ossified skulls and enlarged testes (up to 5×10 mm). From the degree of skull ossification, these males clearly were not recently fledged birds, and on the basis of the enlarged gonads, they may have been in reproductive condition. These specimens strongly suggest that this species has delayed plumage maturation.

DIET—Stomach contents of collected individuals included spiders (Araneae), Orthoptera, beetles (Cucujidae, Elateridae, Scarabaeidae), Homoptera, and Hymenoptera. On the basis of stomach contents and direct observations, the diet of this species is exclusively insects and includes butterflies, moths, and lacewings. This species has been observed following *Coua gigas* and feeding on insects disturbed by them. In gallery forest *Terpsiphone* was most often seen in *Rinorea greveana* and *Tamarindus indicus*, which they use as perches from which to hawk insects.

BREEDING—Most of the adults collected in the littoral forests of Manafiafy, Mandena, and Petrikely from mid-September to early October appeared

to be just entering the breeding season. By mid-October there was a noticeable enlargement of the gonads and nest building activity was observed, although copulations were observed as early as 6 October. From late November to mid-December this species was found in the Marosohy Forest in various stages of breeding: adult males were holding and defending territories, a female had a partially shelled egg in the oviduct, adults were observed feeding fledglings, and subadults with partially ossified skulls were collected. Males in breeding condition lacked brood patches. On 23 October at 810 m in parcel 1 of the RNI d'Andohahela, a female was incubating a nest situated 6 m up in a tree; nests are generally within 2 m of the ground. In the same forest at 1200 m on 9 November, a male and female were feeding a single recently fledged juvenile.

In the dry forests of Malaza and Bealoka the open-cup nests of *Terpsiphone*, often placed low to the ground, were relatively easy to find. The highest density of breeding birds noted in this region was in reserve 3 of the RP de Berenty, which is dominated by dense stands of *Pithecellobium dulce*. Nests were also placed in thorny shrubs such as *Capparis sepiaria* or *Azima tetracantha* and in nonspiny saplings, e.g., *Rinoria greveana*. In this region, the first half of October is a period of nest building, and by mid-November fledglings are seen, although in some years the breeding season is earlier and fledglings are noted in early October.

WEIGHT—Female (11), 13.9 ± 1.4 (12.0–17.0) g; male (23), 13.8 ± 1.0 (12.0–15.5) g; combined (66), 14.0 ± 1.1 (12.0–17.0) g.

SOFT PART COLORS—Bill: bright bluish gray or with black tip, and sometimes mandible completely black; mouth lining: yellow or greenish yellow; legs: gray or dark bluish gray; claws: black; iris: dark brown; orbital ring: bright purplish blue or bright blue in males in breeding plumage and less developed and often less brilliant in females. **Fledglings**—Bill: brown with bright yellow gape; mouth lining: bright yellow; legs and claws: creamy gray.

LOCAL NAMES—*Angetry* (Manombo), *rengetry* (Manafiafy, Marosohy), *rimaly* (Berenty, Bealoka).

Timaliidae

Oxylabes madagascariensis White-throated Oxylabes

The White-throated Oxylabes was relatively common in the humid forest sites of Marovony,

Marosohy, RNI d'Andohahela (parcel 1), Bezavona, and Manantantely between 50 and 1900 m. In almost all cases it was noticed or heard calling from within 1–2 m of the ground and was often difficult to observe because of its skulking habits. In the RNI d'Andohahela (parcel 1) this species was observed in all elevational zones between 440 and 1900 m, although it was most common at 810 and 1200 m and scarce at the highest elevations. This species has been collected 30 km NNW Fort-Dauphin (MNHN) and near Eminiminy (SMF). A specimen was taken in 1756 near Fort-Dauphin (Stresemann, 1952). This species was not recorded at any littoral forest site in the region.

On 28 September in the Manantantely Forest, at approximately 75 m and 16h00, a diurnal forest-dwelling rodent, *Nesomys audeberti*, was observed on the forest floor digging in the leaf litter. On the ground near the rodent were two *Oxylabes madagascariensis*, three *Phyllastrephus zosterops*, and at least two unidentified species of birds. The rodent soon became aware of human presence and fled further into the forest. Whether the interaction between birds and rodent was a coincidence, whether the birds were momentarily attracted to the rodent's activity, or whether they were following it to catch prey flushed by the rodent remains unclear.

DIET—A bird collected 30 km NNW Fort-Dauphin had insect remains in its stomach (MNHN). Stomach contents of individuals collected in 1989 and 1990 contained spiders (Araneae), beetles (Scarabaeidae), Homoptera, and Orthoptera (Goodman & Parrillo, in press).

BREEDING—On 28 September in the Manantantely Forest a pair of adults was noted with at least two fledglings. On 3 November in the Marovony Forest an adult female was netted with two fledglings. Breeding records from the RNI d'Andohahela (parcel 1) include an adult carrying food, presumably to a nest, on 30 October at 810 m and seven observations of adults with fledglings, between 28 September and 22 November; six of the seven observations were of adults with two fledglings and in one observation there was a single fledgling. An open cup-shaped nest was located and photographed on 2 December at 1340 m in the Antanandava Forest of the RNI d'Andohahela (B. Fisher, pers. comm.). The nest was 1.2 m off the ground near a rocky outcrop and contained two eggs.

WEIGHT—Combined (9), 23.3 ± 2.8 (18.0–27.5) g; subadult (2), 21.5, 23.0 g.

SOFT PART COLORS—Bill: maxilla brownish

black to black with cold gray cutting edge, and mandible variable from cold gray to black at base with gray along most of length; legs: dull brown or slate black; iris: brown. **Fledglings**—Bill: maxilla brownish black with dull yellow tip, and mandible dull yellow with brown spot near tip; legs: brown; iris: dark tan.

Crossleyia xanthophrys Yellow-browed Babbler

In southeastern Madagascar the Yellow-browed Babbler was only noted in the Marosohy Forest between 425 and 850 m and in the RNI d'Andohahela (parcel 1) between 800 and 1800 m. This species was generally observed on moist ground in closed-canopy forest, often in areas with dense stands of climbing bamboo.

JUVENILES are duller and darker in plumage coloration than are the adults, particularly the supercilium, breast, and underparts. Adults had all pale pink bills, whereas the bills of juveniles had darker culmens and tips.

DIET—The stomach contents of a collected bird consisted exclusively of small insects, probably beetles.

BREEDING—The following information concerns observations in parcel 1 of the RNI d'Andohahela. Between 13 and 19 November pairs of adults were observed at 1200 m and 1500 m with single juveniles or groups of two juveniles. A male obtained on 9 November at the same elevation had testes 5×4 mm (left) and 4×3 mm (right) and no brood patch. On 25 November at 1500 m, an adult was feeding at least two newly fledged juveniles. A pair was observed building a nest between 21 and 24 November, at 1500 m. The base of the nest was large and bulky, about 15 cm deep, and was made of bamboo leaves and branches. This may have been a natural accumulation of vegetable material on which the nest was built. The nest itself was a deep cup, 6–8 cm across, lined with bamboo leaves and moss and about 2 m above the ground. Two adult birds were observed adding bamboo leaves and moss to the nest. When an adult sat in the nest, the bird was almost hidden, with only the top of the head and the end of the tail protruding.

WEIGHT—Combined (4), 22.4 ± 4.1 (19.5–28.5) g.

SOFT PART COLORS—Bill: variable from ivory pink with brown around nasal operculum to com-

pletely grayish pink; legs: pinkish gray to dull gray; iris: dark brown.

Mystacornis crossleyi Crossley's Babbler

In southeastern Madagascar Crossley's Babbler was restricted to the humid forests of Marovony, Analalava, Marosohy, RNI d'Andohahela (parcel 1), Bezavona, and Manantantely between 50 and 1500 m. We have no records of it in littoral forest. This species apparently is confined to areas of intact humid forest with closed canopy and open understory. It frequently was noted foraging on or next to fallen trunks or rotten trees, where the babbler would probe mosses and epiphytes with its bill.

The juvenile plumage coloration is dull brownish gray above and warmer brown below, with a whitish moustache and small spot behind the eye, as in the adult.

DIET—Stomachs of three individuals contained spiders (Araneae: Salticidae), Blattodea, Dermaptera, Hemiptera, Homoptera, Orthoptera (Acrididae), and Hymenoptera (Formicidae) (Goodman & Parrillo, in press).

BREEDING—On 13 November at 1200 m in parcel 1 of the RNI d'Andohahela, a male was feeding a well-grown juvenile. On 7 November in the Analalava Forest a subadult with a partially ossified skull was collected. A female with an enlarged ovary and two corpora lutea was collected in the Bezavona Forest on 27 December. A male taken on 3 December in the Marosohy Forest had testes 5×3 mm and no brood patch.

WEIGHT—Female (1), 23.5 g; male (2), 24.0, 28.5 g; combined (6), 24.6 ± 2.7 (21.0–28.5) g; subadult (1), 24.5 g.

SOFT PART COLORS—Bill: maxilla black with grayish blue cutting edge, and mandible grayish blue; mouth lining: yellow; legs: grayish pink or pale gray; claws: grayish white or gray; iris: brown.

LOCAL NAME—*Fatsatsatry* (Marosohy).

Nectariniidae

Nectarinia souimanga souimanga and *Nectarinia souimanga apolis* Souimanga Sunbird

The Souimanga Sunbird is one of the most common and widespread birds in southeastern

Madagascar from the Marovony Forest south along the coast and through the Anosyenne and Vohimena mountains to the southern coast and west across the spiny forest to the Mandrare River, from near sea level to 1900 m. In the humid forest of the RNI d'Andohahela (parcel 1) this species was recorded along the complete elevational transect, although it was most frequent between 810 and 1900 m and seemed markedly less common at 440 m. This species frequents areas of intact and secondary littoral, humid, spiny, and gallery forests, heavily degraded habitats, and gardens and agricultural areas. It was encountered at every forest visited, regardless of condition. In and at the edge of littoral forest this species was often abundant. Throughout most of the region it was sympatric with *N. notata*.

Specimens collected at Ankapoky are referable to *N. s. apolis*, whereas specimens from other localities east of the Anosyenne Mountains are of *N. s. souimanga*. The only exception is material from Petriky, which appears to be intermediate between *N. s. souimanga* and *apolis*.

DIET—A bird taken near Mandena had spider remains in its stomach (MNHN). The vast majority of stomachs of specimens we examined contained spiders (Araneae), although a few individuals were found of Hemiptera, Homoptera (Cicadellidae), Coleoptera (Elateridae), Orthoptera, and Hymenoptera (Apoidea, Formicidae) (Goodman & Parrillo, in press).

Flower nectar would probably be indiscernible in the stomach remains. Flowering plants that *N. souimanga* is known to visit include *Citrus*, *Malva*, *Hibiscus*, *Mascarenhasia*, *Euphorbia tirucalli*, *Agave rigida*, *Opuntia*, *Delonix regia*, *Tamarindus indica*, *Dicoma*, *Acacia farnessiana*, *A. sakalava*, *A. rovumae*, *Albizia polystyphilla*, *Kalanchoe beharensis*, *Aloe vaombe*, *A. divaricata*, *Cynanchum* spp., *Cordia* spp., *Sarcostemma decorsei*, *Capparis chrysomeia*, *Maeura filiformis*, *Eucalyptus citriodora*, and *Fernandoa madagascariensis*. In most cases *N. souimanga* feed on nectar of these plants, but it also takes advantage of blossoms, such as those of Asclepiadaceae and Fabaceae, to catch small insects that are attracted to the flowers. Although flowers of over 25 species of plants provide *N. souimanga* with food in the gallery forests of Berenty and Bealoka, *Tamarindus* flowers are a dominant food resource between the months of January and June. Also, the sunbirds' territoriality over patches of *Aloe* indicates guarding of the flowers. In numerous cases the larger and longer-billed *N. no-*

tata was observed frequenting the same plants as *N. souimanga*, and there was interspecific aggression. *N. souimanga* also visits *Agave* flowers to catch insects and drink sap from holes gouged in the stalks by *Lemur catta*.

Although *N. souimanga* is presumed to be a year-round resident in southeastern Madagascar, there are seasonal influxes of *N. souimanga* in gallery and spiny forest that appear to be correlated with the flowering of certain plants. During September and October at Hazofotsy, *Aloe divaricata* is in flower, and considerable numbers (perhaps hundreds) of *N. souimanga* may occur in an area of about 2 ha. Likewise in the botanical garden of RP de Berenty, flowers of *A. vaombe*, which blossom in July, have the same effect. Both *Fernandoa madagascariensis* and *Kalanchoe beharensis* are among the most commonly visited plants, and in July and August, when in flower, there is a noticeable increase in the number of sunbirds.

At the summit of Trafonaomby (1960 m) on 26 November, two female *N. souimanga* were apparently disputing feeding access to a dense clump of *Bakerella* flowers. One female successfully defended the patch by perching next to it and flapping her wings slowly while opening and closing her bill in the rhythm of the wingbeats. She did not call while displaying. On 1 December, two female *N. souimanga* disputed the patch with a male *Neodrepanis hypoxantha*.

BREEDING—Numerous individuals taken throughout the region and in various types of habitats between late September and late December had enlarged gonads and appeared to be breeding. Evidence of nesting was found at several littoral sites in October. A nest with two eggs was found at Petriky on 2 October. On 8 October a female that had a partially shelled egg in the oviduct was collected as she was building a nest. Fledglings were observed or collected in the months of September, October, and November. Between 1 and 6 November in the RNI d'Andohahela at 810 m, a male and a female were feeding at least two nestlings in a spherical or ovoid nest placed 1.5 m off the ground in an area of dense vegetation. Males lacked brood patches.

WEIGHT—*Nectarinia s. souimanga* female (16), 6.9 ± 0.6 (5.5–7.6) g; male (16), 7.6 ± 0.8 (5.5–8.5) g; combined (43), 7.2 ± 0.7 (5.5–8.5) g. *N. s. apolis* female (2), 6.0, 6.0 g; male (3), 6.2, 6.7, 7.0 g; combined (7), 6.2 ± 0.5 (5.2–7.0) g.

SOFT PART COLORS—Bill: black and in subadults distinct yellow fleshy gape; legs and claws:

black or dark brown and in fledglings gray; iris: dark brown. No difference was found in soft part colors between *N. s. souimanga* and *N. s. apolis*.

LOCAL NAMES—*Bitraky*, generic for *Nectarinia* spp. (Manombo); *soy* (RNI d'Andohahela, parcel 1); *soy kely* (Marosohy); *soy manga* (Manafiafy); *tsiksoysoy* (Berenty, Bealoka, Hazofotsy).

Nectarinia notata notata

Long-billed Green Sunbird

In southeastern Madagascar the Long-billed Green Sunbird is found from the Marovony Forest south along the coast and through the Anosyenne and Vohimena mountains to Petriky and west across the spiny forest to the Mandrare River between near sea level and 1200 m. This species was relatively common in littoral and humid forests in both pristine and heavily disturbed condition, but was distinctly less common in the spiny forest area. It was noted on occasion in gardens of Tolagnaro and Manambaro. In general this species was broadly sympatric with *N. souimanga* but was less common.

In dry and spiny forest areas *N. notata* appeared to be seasonally migratory and was often absent for long periods. Between July and September it arrived in the region, usually in low numbers. During this period *N. notata* exhibits territorial behavior, i.e., guarding the flowers of ephemerally available food plants to the point of exhaustion, particularly to thwart the visits of conspecifics and *N. souimanga*. For example, on 20 August individuals of *N. notata* were defending different flowering *Fernandoa* trees in the Malaza Forest. One *N. notata* was observed chasing five different *N. souimanga* from its patch. The *notata* returned to the site and would occasionally feed at the tree's flowers. Ten days later, no *notata* were observed in the immediate area of the *Fernandoa* trees. Near Hazofotsy this species also has been observed between July and February.

DIET—Two birds collected near Mandena had spider debris in their stomachs (MNHN). The majority of specimens collected in 1989 and 1990 had arthropod remains in their stomachs, including spiders (Araneae), beetles (unidentified adults and larvae), and ants (Formicidae) (Goodman & Parrillo, in press). The exception was an adult female taken in the Analalava Forest on 9 November that had a quantity of small seeds in her stomach. In the Ankapoky Forest we saw this species

feeding on the flowers of *Opuntia cactus*. Near Berenty and Hazofotsy the favored flowers are various leguminous plants, *Aloe divaricata*, *A. vaombe*, *Fernandoa madagascariensis*, and *Agave rigidia*.

BREEDING—Several specimens taken in October and November had enlarged gonads, including males with testes up to 8×6 mm and females with enlarged ovaries and ova up to 6 mm in diameter. On 14 September at Mandena a fledgling was observed being fed by an adult male. Birds in juvenile plumage and with partially ossified skulls were obtained at Manafiafy on 18 October.

WEIGHT—Female (5), 13.8 ± 1.7 (12.0–16.0) g; male (9), 15.4 ± 1.2 (13.8–17.0) g; combined (17), 14.8 ± 1.4 (12.0–17.0) g.

SOFT PART COLORS—Bill, legs, and claws: black; iris: dark brown.

LOCAL NAMES—*Bita* (Marovsky), *katia* (Manafiafy), *soy lehibe* (Marosohy).

Zosteropidae

Zosterops maderaspatana maderaspatana Madagascar White-eye

The Madagascar White-eye was found in humid forest from the Marovsky Forest south through the Anosyenne and Vohimena mountains to the Manantantely Forest. It was noted in forest interior and forest edge and in disturbed areas. Mandena was the only littoral forest in which it was found, where the only record was a single mist-net capture. This species's elevational range is from near sea level to 1950 m. A specimen dated 1756 was collected near Fort-Dauphin (Stresemann, 1952). In general this species was uncommon in dry forest, although it was seasonally common in the RP de Berenty and in parcels 2 and 3 of the RNI d'Andohahela. An individual was collected by Bluntschli near Amboasary-Sud in early November (SMF).

The Madagascar White-eye is one of the most regular members of mixed-species flocks. In humid forest of Marosohy above 425 m, 53% of the observed mixed-species flocks contained this species. This percentage is similar (over 60%) to that for flocks containing *Zosterops* reported from the RS d'Analama (Périnet) by Eguchi et al. (1992), who considered *Zosterops* to be a nuclear species in mixed-species flocks. In some cases considerable numbers are

observed. For example, on 25 May, along the Tanatana Trail in parcel 1 of the RNI d'Andohahela at about 200 m, a mixed-species flock was observed that contained two *Coracina*, at least one *Hypsipetes*, two *Newtonia brunneicauda*, two *Terpsiphone*, 25 *Zosterops*, one *Leptopterus viridis*, two *Cyanolanius*, and two *Dicrurus* (OL & SOC).

DIET—Individuals taken in the general Tolagnaro area (MNHN) had a variety of seeds in their stomachs, including those from a plant locally known as *arongana*. The stomach contents of individuals we collected contained gastropods, spiders (Araneae), Blattodea (ootheca), beetles (Curculionidae), Homoptera, Diptera, Hymenoptera, and small seeds (Goodman & Parrillo, in press). In the Marosohy Forest at 900 m a flock of over 15 Madagascar White-eyes was observed feeding on the fruits of a *Macaranga*. In dry areas, *Zosterops* is a relatively common visitor to sisal flowers and flowers of *Tamarindus indica*, *Rinoria greveana*, *Capparis chrysoneia*, *Crateva excelsa*, and *Cordia ronnii*, to fruits of *Phyllanthus seyrigii*, and to leaf shoots of *Acacia rovumae*. Visits to flowers may not always be for nectar, and this species may consume pollen and stamens of *Crateva* and *Acacia*.

BREEDING—None of the eight specimens collected by Milon in February and May near Tolagnaro (MNHN) had enlarged gonads. Several individuals obtained in more recent years in November and December were in or approaching breeding condition (FMNH). For example, a female taken on 7 November in the Analalava Forest (weight = 13.5 g) had a partially shelled egg (weight = 2.5 g) in the oviduct and no corpus luteum, and the largest ovarian follicles were 7, 5, and 3 mm. Males with large testes lacked brood patches. On 28 November in the Marosohy Forest a pair of birds was feeding two fledglings. On 21 November at 1200 m in parcel 1 of the RNI d'Andohahela a mixed-species flock contained at least 10 *Zosterops*, with three or four juveniles.

WEIGHT—Female (4), 11.3 ± 2.1 (8.5–11.5) g; male (5), 10.4 ± 0.9 (9.2–11.5) g; combined (34), 10.7 ± 1.4 (8.5–13.5) g.

SOFT PART COLORS—Bill: maxilla black, and mandible black along distal 50–75% with gray base; legs: dark gray; claws: gray; iris: dark brown.

LOCAL NAMES—*Angoiky* (Marosohy), *bemaso* (Berenty), *siay* (Manombo).

Vangidae

Calicalicus madagascariensis

Red-tailed Vanga

The Red-tailed Vanga was relatively common in closed-canopy humid forests from Marovony south through the Anosyenne and Vohimena ranges to Manantantely. We recorded this species between 50 and 1600 m. In parcel 1 of the RNI d'Andohahela it was recorded between 440 and 1500 m but was most common at 440 and 810 m and much scarcer above 1200 m. Appert (1985) reported this species from Bemangidy. There are also specimens (MNHN) taken 30 km NNW Fort-Dauphin. There is a specimen dated 1756 from "Fort-Dauphin," which is also the restricted type locality of this species (Stresemann, 1952; Rand, 1960). This species was noted in both pristine and heavily degraded humid forest. We did not record this species in littoral forests of southeastern Madagascar. In the 1960s or 1970s G. Randrianasolo observed *Calicalicus* near the Station Forestière de Mandena, a littoral forest site. The station is less than 2 km from the edge of the humid forest; however, it is not clear if this species was observed at Mandena proper. It is generally absent from the spiny forest of southeastern Madagascar, although it has been recorded in the RP de Berenty (Langrand, 1990; Nagata et al., 1992).

The Red-tailed Vanga was regularly noted in mixed-species flocks occurring in humid forests; it was a member of over 70% of plurispecific flocks observed. There is circumstantial evidence that this species may play a central role in the formation of the flocks. For example, on one occasion in the Analalava Forest *Zosterops*, *Nectarinia souimanga*, and *N. notata* flew in to within a few meters of the tape recorder seconds after the song of *Calicalicus* was played.

DIET—The stomach of a bird taken 30 km NNW Fort-Dauphin (MNHN) contained "débris seulement animaux." Stomachs of our specimens contained spiders (Araneae), beetles (Curculionidae), Orthoptera, and Homoptera (Goodman & Parrillo, in press).

BREEDING—A male displayed to a female on 3 November at 810 m in parcel 1 of the RNI d'Andohahela. The male followed the female closely for several minutes, fanning his tail widely, spreading and drooping his wings, and calling. The male was in typical female plumage but with scattered black gular patches and thus was probably molting from immature to adult plumage.

Another male observed the next day giving the same display was in full plumage. A male taken on 7 November in the Analalava Forest had testes 8×6 mm (left, bilobed) and 4×3 mm (right).

WEIGHT—Male (2), 16.5, 18.0 g.

SOFT PART COLORS—Bill: black with gray base and cutting edge; legs: gray; claws: black; iris: brown.

Scetba rufa rufa

Rufous Vanga

The Rufous Vanga was recorded in humid forests from the Marovony Forest south through the Anosyenne and Vohimena mountains to the Manantantely Forest between 50 and 850 m. In the humid forest of the RNI d'Andohahela (parcel 1) this species was only recorded at 440 and 810 m, where it was restricted to areas with large canopy trees on shallow slopes. Appert (1985) reported it from the Bemangidy Forest, and Bluntschli collected it near Eminiminy (AMNH). The only record we have from littoral forest is one bird in October in the strand forest of Manafiafy. A specimen taken in 1756 was from near Fort-Dauphin, which is the type locality of this subspecies (Stresemann, 1952; Rand, 1960). All material examined from southeastern Madagascar is referable to *S. r. rufa*.

DIET—Stomachs of collected individuals contained spiders (Araneae: Salticidae), beetles (Attalabidae, Buprestidae, Cleridae, Elateridae, Scarabaeidae, Staphylinidae), Hemiptera (Reduviidae), Homoptera, flies (Asilidae), ants (Formicidae), and crickets (Gryllidae) (Goodman & Parrillo, in press).

BREEDING—On 27 October at 400 m in parcel 1 of the RNI d'Andohahela, a pair was observed building a nest in a low fork of a tree 5 m from the ground. The nest was made of mosses and thin branches and was a deep cup shape. Both the male and the female brought nesting material.

Adults collected in the Analalava Forest in early November and in the Marovony Forest in late October and early November were in or approaching reproductive condition, including adult males with testes size ranging from 7×4 mm to 10×8 mm. In the Marosohy Forest in early December a pair of adults were observed feeding three fledglings.

WEIGHT—Female (2), 34.5, 40.5 g; male (3), 38.0, 38.0, 40.0 g; combined (8), 36.8 ± 4.9 (34.5–40.0) g.

SOFT PART COLORS—Bill: cold grayish blue;

legs: gray; claws: dark gray; iris: orangish red.
Fledglings—Bill: dark gray with yellow mottling; legs: gray to cream colored; claws: gray; iris: brown.

Vanga curvirostris curvirostris and *Vanga curvirostris cetera*

Hook-billed Vanga

The Hook-billed Vanga was recorded from the Marovony Forest south along the eastern coast and through the Anosyenne and Vohimena ranges to Petriky and west across the spiny forest to the Mandrare River, from sea level to 1200 m. It was the most widespread and locally common vanga observed at low elevations in southeastern Madagascar. It was rarely noted in groups of four or five individuals. In the RNI d'Andohahela (parcel 1) this species was recorded at 440 and 1200 m, although it presumably occurred at low densities between these elevations. On 23 October, at 440 m in parcel 1 of the RNI d'Andohahela, two birds were countersinging. Their calls provoked great agitation from nearby *Phyllastrephus madagascariensis*, *Newtonia brunneicauda*, *Oxylabes madagascariensis*, and *Nectarinia souimanga*, who approached the Vanga and called loudly. On another occasion in the same forest (13 November, 1200 m), a silent *V. curvirostris* was being mobbed by a large group of passerines, including *Neomixis*, *Newtonia* spp., *Leptopterus viridis*, *Cryptosylvicola randrianasoloi*, and *Dicrurus forficatus*.

This species is tolerant of habitat disturbance. For example, it nests in areas of spiny forest with extensive livestock damage and in monoculture stands of *Pithecellobium dulce*.

All specimens studied from humid and littoral forest sites in southeastern Madagascar are referable to *V. c. curvirostris*. The type locality of this subspecies has been restricted to Fort-Dauphin (Stresemann, 1952; Rand, 1960). Material from the spiny forest portion of the region collected in parcel 2 of the RNI d'Andohahela is referable to *V. c. cetera* (FMNH).

DIET—*Vanga* primarily feeds on large insects and small vertebrates. At Manantantely this species has been observed taking young Brown Mouse Lemurs (*Microcebus rufus*) (Goodman et al., 1994b). In dry forests and to a lesser extent humid forests, chameleons make up a significant portion of this bird's diet. Including the tail, these chameleons may be almost as long as the bird

itself. Chameleons are generally killed by holding them in the bill and whacking them against a branch. On several occasions Hook-billed Vangas wedged the large head of the dead chameleon into the fork of two branches, with the body of the chameleon hanging free below. On one occasion the chameleon was not dead when its head was wedged in the tree fork and was then dispatched by the bird by tugging at its body. The suspended carcass is then dismembered, piece by piece, by the vanga. The bird begins this process at the rear of the carcass, with the tail or hind limbs, often perching below the chameleon and reaching with the its heavy bill. Portions of the chameleon are fed to other individuals (presumably fledglings). The same butchering posts are regularly used by this species. Nestlings are also fed geckos, skinks, cockroaches, and a variety of other invertebrates.

Cicadas often form a substantial portion of this vanga's diet, particularly during periods of emergence in November and December. The stomach contents of collected *Vanga* consisted of spiders (Araneae), centipedes (Geophilomorpha, Scolopendromorpha), flies (Asilidae), crickets (Gryllidae), beetles (Chrysomelidae, Curculionidae, Elateridae, Scarabaeidae), cicadas (Cicadidae), true bugs (Psyllidae), Mantodea, ants (Formicidae), small amphibians, geckos (cf. *Phelsuma*), chameleons, and an unidentified passerine (Goodman & Parrillo, in press).

BREEDING—This species commences nest construction in August, and eggs hatch in late September. During some years active nesting is noted during November and December; however, records from these months may represent renesting by birds whose first clutch failed. A nestling was collected on 2 November at Amboasary-Sud (SMF). The gonads of adults collected in mid-September to late October ranged from small to large and in reproductive condition. An adult male taken on 17 October at Itapera had slightly enlarged gonads and a nonvascularized brood patch.

The nests of *Vanga* are large, and nest placement is very stereotyped, which makes nests of *Vanga* among the easiest to find of any bird species in gallery and spiny forests. The open-cupped nests are lined with spider web (often *Nephila*) and usually lodged at the top of the trunk's bole at the point where the primary branches radiate from the main trunk. In several cases the same nest was reused over several consecutive breeding seasons, although it often was necessary for the vangas to repair the structure. In the RP de Berenty one nest was used for six consecutive sea-

sons. Preferred tree species for nest sites were *Crateva excelsa*, *Celtis philippensis*, *Pithecellobium dulce*, and, less frequently, *Acacia rovumae*, *Ficus grevei*, and *Alluaudia procera* (in spiny forest). Nesting sites are in both closed-canopy and open-canopy forests. The clutch is usually three or four eggs. Both parents incubate and feed the young. Nests are heavily predated by *Corvus albicans*, presumably because they are visible and accessible to these crows.

WEIGHT—*Vanga c. curvirostris* female (2), 65, 71 g; male (7), 71.6 ± 2.8 (68–75) g; combined (12), 71.0 ± 2.8 (65–75) g. *V. c. cetera* male (1), 58.5 g.

SOFT PART COLORS—Bill: black with whitish gray spot toward tip of maxilla; legs: dull bluish gray; claws: black and occasionally dark gray; iris: brown.

LOCAL NAMES—*Fifiokala* and *tsilovanga* (Berenty), *vanga* (Manafiafy, Manombo).

Xenopirostris xenopirostris

Lafresnaye's Vanga

Lafresnaye's Vanga reaches its easternmost distributional limit in southeastern Madagascar, where it is an uncommon inhabitant of the spiny forest portion from at least the Ankapoky Forest north to Hazofotsy and west to the Mandrare River, between near sea level and about 150 m. It was observed in both pristine and disturbed spiny forest. In the spiny forest adjacent to the Mananara River, east of Hazofotsy, in the RNI d'Andohahela (parcel 2), probably no more than two or three pairs occurred along the 5 km of trail surveyed during the 1995 inventory of the region. A specimen was collected in late October at Amboasary-Sud (SMF).

This species is largely confined to spiny forest and the transitional zone between gallery and spiny forest. It regularly visits dead or dying trees with cracks or loose bark. It uses probing and levering movements of its bill to extract insects, particularly from various *Euphorbia* trees.

Xenopirostris polleni

Pollen's Vanga

In southeastern Madagascar this species is largely confined to intact humid forest between 440 and 1950 m. All of our records from the region are from the Marosohy and Marosalohy for-

ests and parcel 1 of the RNI d'Andohahela. During the inventory of the latter forest parcel, this species was recorded between 810 and 1950 m but apparently was most common at 1200 m. Milon collected a specimen 30 km NW Fort-Dauphin (MNHN).

Between 27 November and 4 December, in transitional forest north of Trafonaomby, a minimum of two pairs were located. This species frequently foraged in low *Philippia* shrubs up to 100 m from the edge of closed-canopy forest, where they were seen to catch and eat buprestid beetles. A male was observed on several occasions at the summit of Trafonaomby (1960 m), where vegetation was low (about 1.5 m high) and dense and composed mostly of ericoid shrubs. This site is about 500 m higher than the previously reported elevational limit of this species (Langrand, 1990).

On 29 October at 810 m in parcel 1 of the RNI d'Andohahela, a male *X. polleni* was seen mobbing a *Galidia elegans* by swooping down to near the mammal's head and clacking its bill. While mobbing, the bird also gave a quiet "chuck-chuck-chuck" call.

One juvenile was observed in close detail; it had a pale creamy orange underside (paler than an adult female) with a complete but not very extensive black hood (cf. Putnam, 1996). The bill was pale gray in the middle of both mandibles and pinkish along the culmen and cutting edges. The legs and feet were pale gray, paler than the adults', which were dark gray. The fleshy gape was obvious and pale orange, as was the narrow eye ring.

On at least two occasions in the RNI d'Andohahela *X. polleni* was observed chasing *Tylas eduardi*. It is not clear why these species should display interspecific aggression; their foraging methods are different (Yamagishi & Eguchi, 1996; pers. obs.), although the plumage patterns of *Tylas* and female *X. polleni* are very similar.

DIET—The stomach of a Milon specimen contained a large spider, caterpillar, and insect debris (MNHN). Like its congener *X. xenopirostris* of the spiny forest, *X. polleni* forages by searching for invertebrates concealed in woody substrates or among epiphytes. *Oriolia bernieri*, which, like *X. polleni*, is a vanga found in the eastern humid forest, also has very similar foraging behavior. *Oriolia* and *X. polleni* both climb up medium-sized or thick branches and strip off moss and loose bark, and both species characteristically perch on top of a horizontal branch and peer un-

derneath before tearing off some moss with the bill from the lower part of the branch.

The distributions of *Oriolia* and *X. polleni* are imperfectly known, but they may be largely exclusive. *Oriolia* is found only in the northern portion of the eastern humid forest. The center of distribution of *X. polleni* appears to be in the southeast and east-central portions of the eastern humid forest, largely south of the range of *Oriolia*. The status of *X. polleni* within the range of *Oriolia* is not clear. There is a sight record of *X. polleni* from near Maroantsetra (Collar & Stuart, 1985), where *Oriolia* is uncommon (Langrand, 1990; pers. obs.). There is also a sight record of *X. polleni* from the RNI de Marojejy (Benson et al., 1977), although this species was not recorded there in a later survey (Safford & Duckworth, 1990) or in the nearby RS d'Anjanaharibe-Sud (Hawkins et al., in press); *Oriolia* is known from both of these reserves. Perhaps the general pattern of largely exclusive distributions and the apparent rarity of *X. polleni* in areas occupied by *Oriolia* can be explained in part by their similar foraging techniques, which suggests that they might compete for food resources.

BREEDING—The testes of the Milon specimen collected on 26 May were 2×0.6 mm. The following observations are from parcel 1 of the RNI d'Andohahela. On 15 November at 1200 m, a female-plumaged bird was carrying food. On 9 November at the same elevation, a probable immature male (it had a blotchy pink breast and was speckled black on the central breast) was collecting leafy fibers, presumably for nesting material. On 29 November at 1900 m, over a period of 40 minutes, an adult male fed small insects five times to a juvenile. A female was in the vicinity but was not observed attending the juvenile during this feeding bout. The juvenile stayed in the same place for the whole period, calling continuously and quietly.

Falculea palliata Sickle-billed Vanga

In southeastern Madagascar the Sickle-billed Vanga is confined to the spiny forest, where it is often locally common in spiny and to a lesser extent in gallery forest between 10 and 100 m. In gallery forest, this species prefers open areas with tall trees and little or no understory. It is more common in the Bealoka Forest than in the Malaza

Forest. It was collected by Bluntschli near Ambasary-Sud in late October (AMNH, SMF).

Groups of up to 20 individuals were often observed as they moved noisily through the forest, sometimes with *Leptopterus viridis*. *Falculea* probes crevices in trunks and large branches and under bark with its long sickle-shaped bill (Yamagishi & Eguchi, 1996; pers. obs.). On numerous occasions we observed *Falculea* perched or hanging upside down on the main trunks or terminal flower stalks of *Alluaudia* and, with side-sweeping motions of the bill, gleaning insects from the main trunk or inserting their bills into blossoms.

BREEDING—*Falculea* builds large nest structures out of branches and twigs. The nests are often placed in *Alluaudia* or *Adansonia* trees and less often in *Crateva excelsa* trees. On 10 October at Ankapoky and on 15 November at Hazofotsy adult *Falculea* were observed refurbishing a nest that had been used during a previous breeding season. Nests are usually solitary structures, although on occasion several will be in the immediate vicinity of one another. For example, in November 1984, five *Falculea* nests were in a tall isolated *Crateva excelsa* on the outskirts of Bealoka. Two of the nests appeared to be abandoned, and three were in the process of being refurbished. Several *L. viridis* entered the *Falculea* nests, shifted nesting material, and then flew off without damaging the nest or seemingly adding anything to the construction. The nesting and feeding relationships between *Falculea* and *L. viridis* are in need of further investigation.

LOCAL NAME—*Voronzaza* (Berenty).

Leptopterus viridis viridis White-headed Vanga

The White-headed Vanga occurs in humid forest from Marovony south through the Anosyenne and Vohimena mountains at least to parcel 1 of the RNI d'Andohahela and then west into spiny forest to the Mandrare River, between 40 and 1500 m. This species was not recorded in humid forest parcels (e.g., Bezavona and Manantantely) in the vicinity of Tolagnaro, although a specimen was collected in 1756 near Fort-Dauphin (Stressmann, 1952). We also did not find this species in any littoral forest of southeastern Madagascar. In the 1960s or 1970s G. Randrianasolo recorded *L. viridis* at or near the Station Forestière de Mandena. The station, which is in littoral forest, is less

than 2 km from the edge of the humid forest, and it is not clear if this species was observed in Mandena proper.

In the spiny forest area this species was relatively common in both intact and degraded spiny forest and in gallery forest. It occasionally was noted in relatively large groups, e.g., a flock of eight individuals on 5 September in the RP de Berenty (OL). Specimens collected near Amboasary-Sud (AMNH, SMF) in late October are referable to nominate *viridis*, the type locality of which has been designated as Tolagnaro (Stresemann, 1952; Rand, 1960).

Frequently a few *L. viridis* were seen in flocks of *Falculea*, and these two species would forage together. Rather than using side-sweeping motions as *Falculea*, *L. viridis* pokes its bill into trunk crevices or into flowers. *Tamarindus* trees are regularly visited by these two species. *L. viridis* tends to probe into or lever away the tree's bark but is unable to penetrate deeply into crevices and holes. In contrast, *Falculea*'s sickle-shaped bill enables deeper penetration, but it is less adept at peeling bark from trunks. It is possible that *Falculea* benefits from the bark-loosening techniques of *L. viridis*. Indeed, *Falculea* may visit the exact foraging location of *L. viridis* as soon as the latter has departed.

DIET—Stomach contents of collected birds included beetles (Chrysomelidae, Curculionidae), Homoptera, and ants (Formicidae) (Goodman & Parrillo, in press).

BREEDING—In parcel 1 of the RNI d'Andohahela on 27 October at 440 m, a male was seen gathering nest material, probably small sticks. A few days later at 810 m, a male was seen carrying food. In the RP de Berenty an isolated nest of this species, not in association with *Falculea*, was active between 16 and 21 November in a *Neotina isoneura* tree.

WEIGHT—Sex unknown (1), 50.5 g.

SOFT PART COLORS—Bill: cold grayish blue at base merging to dull bluish gray at tip; mouth lining: black; legs: dark gray; iris: brown.

LOCAL NAMES—*Vorompiokoka* and *bifeiko* (Bealoka, Berenty).

Leptopterus chabert chabert and *Leptopterus chabert schistocercus*

Chabert's Vanga

Chabert's Vanga occurs from the Marovony Forest south through the Anosyenne and Vohi-

mena mountains to the Manantantely Forest and west to the Mandrare River, from 40 to 1000 m. This species was observed in both pristine and heavily disturbed humid and spiny forest and in villages and towns not far from the forest edge, e.g., Ranomafana-Sud. We did not record it in the littoral forests of Mandena, Manafiafy, or Petriky. However, G. Randrianasolo inventoried the birds near the Station Forestière de Mandena in the 1960s and 1970s and recorded *L. chabert* locally. The station is within 2 km of the humid forest, and it is not clear if this species was observed in Mandena proper. One individual was noted on 29 May at Sainady, along this same coastal zone. There is a specimen collected in 1756 near Fort-Dauphin, which is the designated type locality of *L. c. chabert* (Stresemann, 1952; Rand, 1960).

This species is rare in gallery forest, unless it is heavily disturbed. In dry forested areas, it is most frequently seen perched on and moving among *Alluaudia procera* trees. Flocks of up to 12–14 individuals have been recorded in this region. Specimens collected in the Ankapoky Forest are referable to *L. c. schistocercus*. Thus, the western slopes of the Anosyenne Mountains may form the divide between *L. c. chabert* and *L. c. schistocercus*.

DIET—The stomachs of individuals collected near Ankapoky in mid-October contained beetle parts, seeds, and small fruits.

BREEDING—Individuals collected in mid-October at Ankapoky were in or approaching breeding condition. Adult males with large testes did not have brood patches. On 13 October in the Ankapoky Forest two adults were attending a small cup-shaped nest about 14 m off the ground attached to the main trunk of an *Alluaudia* tree. Three days earlier at a nearby locality five adult Chabert's Vangas were observed flying around and alighting on a large stick nest about 10 m off the ground in a 20-m-tall *Alluaudia*. The nest may well have originally been constructed by *Falculea*.

WEIGHT—*L. c. schistocercus* female (1), 20.5 g; male (3), 18.0, 19.0, 19.0 g; combined (6), 19.0 ± 0.8 (18.0–20.5) g.

SOFT PART COLORS—Bill: bluish gray or whitish gray; legs and claws: black; iris: brown; orbital ring: mixture of brilliant sky blue and cobalt blue.

Cyanolanius madagascarinus madagascarinus

Blue Vanga

In southeastern Madagascar the Blue Vanga was relatively common at several intact and dis-

turbed humid forest sites. This species was frequently noted in clearings at the edge of the Bezavona Forest. It has been reported from Bemangidy (Appert, 1985). The Mandena Forest was the only littoral forest site in the area at which we recorded this species. In the spiny forest region it was relatively uncommon in spiny and gallery forest, e.g., the RP de Berenty. The elevational range of this species in southeastern Madagascar is from near sea level to 1500 m. The form occurring in the area is *C. m. madagascarinus*, the type locality of which has been designated as Fort-Dauphin (Stresemann, 1952; Rand, 1960).

A multispecies flock encountered in parcel 1 of the RNI d'Andohahela at 1500 m on 26 November contained five individuals, one of which was a juvenile that begged food from and was fed by an adult male.

DIET—The stomach of a bird taken 30 km NNW Fort-Dauphin contained large insect remains (MNHN).

WEIGHT—Sex unknown (1), 22.5 g.

SOFT PART COLORS—Bill: bright cold blue with black tip; legs: black; iris: dull blue.

Hypositta corallirostris

Nuthatch Vanga

The Nuthatch Vanga was relatively uncommon in the region and confined to humid forest from the Marovony Forest south through the Anosyenne and Vohimena mountains to the Manantantely Forest. It was restricted to areas of intact humid forest between 75 and 650 m with large trees that were covered with mosses and epiphytes. In the RNI d'Andohahela (parcel 1) this species was only noted twice, at 440 m and 810 m. Appert (1985) recorded this species in the Bemangidy Forest. Salvan (1970) reported a specimen in the ORSTOM collection that was taken near Pic St. Louis but that cannot be traced. As of 1989 all of the appropriate habitat for this species on Pic St. Louis had been destroyed.

Peters (1996) described a new species, *Hypositta perdit*, on the basis of two Bluntschli specimens, both juveniles, taken near Eminiminy in September 1931. Peters was under the impression that *H. corallirostris* was not known from southeastern Madagascar, although all of our sight records from this region are of birds that appeared to be typical adult *H. corallirostris*. Peters proposed, based on this interpretation of the foot structure of the two Bluntschli specimens, that *H.*

perdit might not have the ability to grasp and climb tree branches and trunks. All of the *Hypositta* that we observed in southeastern Madagascar exhibited the bark-climbing behavior that is typical of *H. corallirostris*. We know of no other juvenile specimens of *Hypositta*, so the characters of *perdit* cannot be compared directly with certain *corallirostris* of comparable age. Further study may show that the characters of *H. perdit* are those of juvenile *H. corallirostris*.

Tylas eduardi eduardi

Tylas Vanga

In southeastern Madagascar the Tylas Vanga was largely confined to large tracts of humid forests between 350 and 1950 m. Our only records from the region were from the large forests in or adjacent to parcel 1 of the RNI d'Andohahela. During the 1995 inventory of the humid forest of this parcel, this species was observed at elevations from 440 to 1950 m, although it was more frequent at 440 and 810 m than at higher altitudes. A specimen was taken 30 km NNW Fort-Dauphin (MNHN). One individual was observed in heavily degraded forest at 940 m near Antseva. We have no records of this species from littoral forest. In the 1960s or 1970s, however, G. Randrianasolo recorded *Tylas* at the Station Forestière de Mandena. The station, which is in littoral forest, is less than 2 km from the edge of the humid forest, and it is not clear if this species was observed in Mandena proper. Langrand (1990) reported *Tylas* from the general Tolagnaro area.

There was considerable variation in plumage coloration of apparent adults. One presumed male observed in courtship feeding had almost completely white underparts rather than the normal dark orange underparts. Another individual with a grayish white ventrum was seen at 810 m on 1 November. Of a flock of four birds noted on 4 November, three were very pale pinkish white underneath, and the coloration of the fourth could not be determined. One bird at 1500 m on 25 November was completely white on the underparts except for a single orange feather on the upper breast.

An individual on 5 November at 810 m sunned itself by leaning its head over to one side, spreading the opposite wing and the tail, and remaining motionless in a patch of sunlight for several minutes. A similar behavior has been observed in *Scetba rufa*.

DIET—One individual that caught a small arboreal cricket held the cricket in its foot as it leaned straight down and consumed the prey.

BREEDING—On 23 October at 440 m in the RNI d'Andohahela (parcel 1), a pair displayed to each other by wing-flicking (both wings were flicked downward and outward rapidly) and by courtship feeding. The specimen in MNHN taken on 28 May had testes 1.8×1.2 mm.

WEIGHT—Male (1), 43.5 g; combined (3), 43.5, 46.0, 55.5 g; fledgling (1), 37.5 g.

SOFT PART COLORS—Bill: black; legs: dull black or brownish black; claws: black; iris: brown and in one case greenish yellow. Fledgling—Bill: maxilla black with dull orange at base, and mandible dull orange for most of its length with black tip; mouth lining and fleshy gape: bright yellowish orange; legs: dull gray; claws: black; iris: light brown with silver cast.

Dicuridae

Dicrurus forficatus forficatus

Crested Drongo

The Crested Drongo was one of the most widespread birds throughout southeastern Madagascar. This species was found in a broad variety of habitats from pristine to heavily disturbed littoral, humid, and spiny forest, eucalyptus, pine, and sisal plantations, agricultural fields, river margins, and gardens in towns and villages between sea level and 1900 m. This bird was one of the few species that appear tolerant of human-induced habitat degradation. It was recorded at all of the QIT study sites and virtually every locality throughout southeastern Madagascar that we visited. It also has been reported from Bemangidy (Appert, 1985).

DIET—Stomachs of collected birds contained spiders (Araneae), beetles (Cerambycidae, Curculionidae, Elateridae, Scarabaeidae, Tenebrionidae), flies (Asilidae), Orthoptera, and Hymenoptera (Goodman & Parrillo, in press). It is a highly versatile forager. It not only sallies into the air and to the ground from elevated perches but also will mob other species carrying captured prey.

BREEDING—*Dicrurus* nests typically in the open and constructs a small, shallow cup in which the adult barely fits. Adults are more often seen perched on top of rather than sitting in the nest cup. Several adults taken in mid-September to mid-October in the Manafiafy, Mandena, and

Manantantely forests were in or approaching reproductive condition. In the Ankapoky Forest two adults were seen on 9 October attending a nest 5–6 m off the ground and placed in the fork between the main trunk and a horizontal branch. On 30 October at 810 m in the RNI d'Andohahela (parcel 1) an adult was on a nest about 8 m off the ground. In the dry areas of the region the breeding season extends from early October to mid-February. In the gallery forest along the Mandrare *Dicrurus* prefers to nest in the lower branches of large trees (*Albizia*, *Acacia*, *Tamarindus*, and *Neotina*). On 23 December two active nests were found in the RP de Berenty (OL), and on 26 December in the Bezavona Forest two adults were seen feeding two free-flying fledglings. Males with greatly enlarged testes lacked brood patches.

During the breeding season *Dicrurus* is exceptionally territorial, and aggressive behavior toward conspecifics and other species of birds is relentless. It regularly is observed mobbing larger species such as *Vanga*, *Eurystomus*, *Leptosomus*, and virtually all birds of prey. Furthermore, *Dicrurus* is a convincing vocal mimic. At Bealoka it sometimes mimics *Hypsipetes* and *Accipiter francesii*.

WEIGHT—Female (1), 45 g; male (6), 49.2 ± 2.8 (44–52) g; combined (15), 47.8 ± 4.7 (36–54.5) g.

SOFT PART COLORS—Bill, mouth lining, legs, and claws: black; iris: dark reddish brown or crimson red. Fledglings—Mouth lining: yellow; iris: brown.

LOCAL NAMES—*Lova* (Berenty), *railovy* (Manafiafy, Manombo, Marosohy).

Corvidae

Corvus albus

Pied Crow

In southeastern Madagascar the Pied Crow was typically found in areas along the eastern coastal plain and across the spiny forest region. The presence of this species in the region was noted by Flacourt (1658) in the 17th century. It was almost exclusively found near human habitation, agricultural fields, and pastureland and occasionally along the seashore. The vast majority of records are between sea level and 50 m, although it is occasionally noted in degraded upland grassland areas such as near Eminiminy and Antseva. In the spiny forest region it does not occur in climax

forest but in open areas. It visits riverbanks on a daily basis, even during the hottest portion of the day. At dusk in areas surrounding spiny forest, a grand exodus of Pied Crows, sometimes numbering several hundred, could be seen flying to roosts. This procession includes birds from the southern Mandrare basin and covers a period of about 1 hour.

Corvus is often gregarious, particularly around concentrated food resources such as fish offal near fishermen's villages and discarded animal remains near slaughterhouses. It takes advantage of windy days to "hover" in the air, particularly along the coast and rivers. As with *Dicrurus*, *Foudia madagascariensis*, and *Lonchura nana*, this species may have benefited from human settlement of southeastern Madagascar.

DIET—One individual collected at Mandena on 1 September had insects, reptile bones, and sand in its stomach. In general it is a voracious nest thief in open areas. This species is probably responsible for the failure of many nests of raptors in conspicuous locations, including *Polyboroides*, *Buteo*, and species such as *Vanga curvirostris*. In the RP de Berenty, *Corvus* takes advantage of orthopteran invasions in meadow areas and also feeds extensively on the pericarps of the introduced *Pithecellobium dulce* tree.

BREEDING—The Mandena specimen was an adult female with an ovary 20×8 mm; the largest ovarian follicle was 3 mm. On 24 December an adult at Lac Anony was on a nest about 10 m up in a *Casuarina* tree at the edge of a barrier dune. In the RP de Berenty and Bealoka this species tends to place its nest toward the top of the tallest *Acacia* trees.

WEIGHT—Female (1), 580 g.

SOFT PART COLORS—Bill, legs, and claws: black; iris: dark brown.

LOCAL NAMES—*Goaka* (Berenty), *goaky* (Manombo), *koaky* (Manafiafy).

Sturnidae

Hartlaubius auratus Madagascar Starling

In southeastern Madagascar the Madagascar Starling was infrequently observed in a variety of habitats between 50 and 1200 m. It was most commonly noted in groups of two to four birds perched in the upper limbs of dead trees at the edge of humid forest, for example at Marovony,

Analalava, Bemangidy, Marosohy, and Bezavona. On 27 December we observed this species near the western edge of parcel 1 of the RNI d'Andohahela, just below the Col d'Ambatomanaha in the ecotone between humid and dry forest. It also has been observed in littoral forest near Mandena. Bluntschli collected this species near Eminiminy in October (AMNH, SMF). There are specimens taken 7 km N Fort-Dauphin (MNHN) and in 1756 near Fort-Dauphin (Stresemann, 1952). In the spiny forest region this species is uncommon.

DIET—The stomach contents of a bird obtained near Mandena (MNHN) consisted of three seeds from a tree locally known as *ambora*. In the RNI d'Andohahela (parcel 1) a group of two to four *Hartlaubius* visited a site near our 810-m camp each morning, generally when it was sunny, to feed on the remains of an exploited beehive.

BREEDING—Specimens taken north of Tolagnaro in late February (MNHN) had small reproductive organs.

Acridotheres tristis Common Myna

This introduced species is a relatively common human commensal throughout southeastern Madagascar in towns and villages and in other heavily modified habitats such as pastureland, agricultural fields, and gardens. Although the year of the observations was not given, Salvan (1970) noted that sometime after 1945 this species was found 30 km west of Tolagnaro and near Amboasary-Sud. In July 1982 it was found near Tolagnaro and in the RP de Berenty. We did not observe this species within the interior of any pristine forest, but it occurs at the edge of littoral, humid, gallery, and spiny forest. In heavily disturbed areas *Acridotheres* will penetrate forested habitats, often at considerable distances from human settlements. In the environs of Tolagnaro we observed flocks of up to 25 Common Mynas foraging on the ground near grazing cattle.

This species is now widespread and has colonized the edge of natural forest areas and remote human settlements, e.g., Tsiombe, Ampanihy, and Ejeda. In the spiny forest this species nests in cavities of baobab trees, where it is more aggressive than native species utilizing the same holes and thus may be displacing them. This displacement may become a serious problem in areas such as the RP de Berenty, where numbers of Common Mynas have increased considerably in recent

years, at least in part related to their utilization of food in open garbage pits. At this site it nests in the eaves of buildings. The subspecies introduced to the island is *A. t. tristis*.

DIET—This species is largely omnivorous, and like *Corvus albus*, it is opportunistic, investigating anything and everything for palatability.

BREEDING—An adult male collected at Tolagnaro on 7 October had testes 8×6 mm (left) and 6×5 mm (right). In the RP de Berenty this species has been found nesting during January and February.

WEIGHT—Male (1), 150 g.

SOFT PART COLORS—Bill, legs, and claws: yellow; iris: gray with white ring of spots; orbital ring: bright yellow.

LOCAL NAMES—*Maritay* (Manombo), *ramaro* (Manafiafy), *rimaro* (Berenty, Marosohy).

Ploceidae

Ploceus nelicourvi Nelicourvi Weaver

The Nelicourvi Weaver is a relatively common bird of intact humid forests from the Marovony Forest south through the Anosyenne and Vohimena ranges to the Manantantely Forest between 50 and 1950 m. In the RNI d'Andohahela (parcel 1) this species was recorded in all zones between 440 and 1950 m. We did not observe it in any littoral forest of southeastern Madagascar. However, in the RS de Manombo, 140 km north of Manantenina, in an area where the littoral and humid forests are separated only by a narrow corridor of open ground, this species was found in both forest types.

DIET—The stomach of a single collected bird contained spiders (Araneae), beetles (Curculionidae), and Homoptera (Goodman & Parrillo, in press).

BREEDING—Adult male and female specimens collected between late September and late December often had enlarged gonads (e.g., testes up to 10×6 mm). Fledglings were netted in the Marovony Forest in late October and in the Bezavona Forest in late December. Males did not possess brood patches. This species generally nests solitarily, and the penduline nest is often attached to a tree limb and suspended over watercourses. This habit may be a adaptation to thwart snake predation on nest contents. On 23 October, in parcel 1 of the RNI d'Andohahela, a female-plumaged

bird was singing near a nest. This bird may have been a young male rather than a female. In the same reserve at 1500 m on 25 November, another apparent immature male was carrying nest material.

WEIGHT—Female (6), 23.1 ± 1.1 (21.0–24.0) g; male (8), 24.6 ± 1.4 (23.0–26.5) g; combined (22), 23.9 ± 1.6 (20.5–26.5) g.

SOFT PART COLORS—Bill: black; legs: brownish gray to black; claws: black and in a few individuals gray; iris: brown to reddish brown. FLEDGLINGS—Bill: black with random yellow patches.

LOCAL NAMES—*Fody ala* (Marosohy), *fodisiay* (Manombo).

Ploceus sakalava minor Sakalava Weaver

The Sakalava Weaver was a common inhabitant of the spiny forest of the region from near sea level to about 100 m. The easternmost records are from the east side of the Col de Ranopiso and the extreme western side of the RNI d'Andohahela (parcel 1), just above the village of Mahamavo, and to the west it occurs to the Mandrare River and beyond. All specimens examined from the region are referable to *P. s. minor*.

DIET—Stomach contents of collected individuals invariably contained insect remains. In the Ankapoky Forest we observed this species picking at *Alluaudia* blossoms; they appeared to be eating the flowers.

BREEDING—Colonies of Sakalava Weavers were often placed in *Adansonia za* and *Gyrocarpus americanus* trees. The breeding regimen of this species appears to be irregular, presumably related to infrequent local rains rather than calendar seasons. In late August a colony was actively nest building in the middle of Anjapolo, 10 km northwest of Bealoka. On 15 November freshly hatched eggs were found below a colony near Hazofotsy. On 19 November birds collected from a colony near Bevilany consisted of an immature male with testes 6×4 mm and adult males and females in or approaching breeding condition. On 23 December of the same year this colony was revisited, and remains of recently hatched eggs were found under the baobab tree. In mid-October numerous Sakalava Weavers in flocks were netted in the Ankapoky Forest. These flocks consisted of immatures, adult males with testes up to 10×8 mm, and females with slightly enlarged ovaries. None of the males had a brood patch. One flock

of + 30 birds, many of which carried nest material in their bills, was seen flying over the forest.

According to local customs wealth and prosperity are brought to a village if Sakalava Weavers choose to nest in a tree overhanging or beside a chief's house. For this reason this species is generally left unmolested in villages.

WEIGHT—Female (6), 22.3 ± 2.6 (20.5–27.5) g; male (9), 25.1 ± 1.1 (23.5–27.0) g.

SOFT PART COLORS—Bill: rather variable from mottled gray and black with light tip, light gray with cream-colored cutting edge to bluish gray; legs: grayish pink; claws: grayish pink; iris: brown, dull red, or dull orangish red; orbital ring: dull cream-colored or dull pinkish gray.

LOCAL NAME—*Fodibeotse* (Berenty).

Foudia madagascariensis Madagascar Red Fody

The Madagascar Red Fody was one of the most common birds of the region from the Marovony Forest south along the coast and through the Anosyenne and Vohimena mountains to the southern coast and west across the spiny forest to the Mandrare River. It frequented a variety of habitats from the edge of littoral, spiny, and humid forests to heavily disturbed areas, including agricultural lands, pasturelands, thick secondary brush, and gardens, generally from sea level to about 1950 m. In the spiny forest these birds are not common in intact gallery forest, and they usually occur in agricultural and degraded areas, often inhabiting the pediplain areas between forest, riverbank, and river.

Immature birds, particularly males, and non-breeding adults congregated in flocks often numbering up to 50 individuals and were observed in ripening grain fields and in gardens. Such a flock, netted in Tolagnaro on 4 October 1990, consisted of 13 individuals, all immatures with partially ossified skulls; 12 were males and one was a female.

DIET—Stomachs of collected individuals contained small insect parts and various types of seeds.

BREEDING—The breeding season of this species appears to be relatively protracted. For example, in the period from mid-September to late November adults were taken in a variety of reproductive states, including active breeding, and during the same period subadults with partially ossified skulls were also obtained. A female taken on 28 May, 30 km NW Fort-Dauphin (MNHN), had an

ovary 8.3×5.1 mm. In the dry parts of the region active nests have been found in May.

WEIGHT—Male (11), 17.2 ± 2.0 (13.5–19.5) g; combined (22), 16.9 ± 2.0 (13.0–19.5) g.

SOFT PART COLORS—Bill: black and occasionally with dark gray mandible; legs and claws: pinkish brown, brown, or gray; iris: dark brown.

IMMATURATES—Bill: maxilla brown, and mandible brownish horn.

LOCAL NAMES—*Folymena* (Berenty), *fody mena* (Manafiafy, Manombo, Marosohy).

Foudia omissa

Forest Fody

In southeastern Madagascar the Forest Fody was distinctly less common than the Madagascar Red Fody. Virtually all of our records of the Forest Fody come from within relatively large tracts of humid forest, e.g., Manantantely and Marosohy Forest and parcel 1 of the RNI d'Andohahela, between 50 and 1900 m. Our only record from littoral forest was two birds netted at Mandena, one of which had an unossified skull (FMNH). At Manantantely, this species was netted close to the forest edge, about 500 m from where a pair of *F. madagascariensis* was captured.

During the 1995 elevational transect of the RNI d'Andohahela (parcel 1), this species was found from 440 to 1900 m, although it was most frequently observed between 1200 and 1500 m. In this parcel it was often difficult to be certain of the identity of many individual *Foudia*; male *F. madagascariensis* may molt into breeding plumage later in the year than *F. omissa*, and hence it may be difficult to distinguish between them. We have no clear evidence of hybridization between this species and *F. madagascariensis*, even in areas where these two species are in close contact (see Benson et al., 1977).

On 30 October, at 810 m in parcel 1 of the RNI d'Andohahela, in the late afternoon a dispersed group of 50–100 *F. omissa* was seen in and around a cluster of large *Sloanea* trees. There was much singing, calling, and flying around, and at least two separate groups of four or five males were seen displaying and calling together. This congregation may have been a roost grouping. Observations in this forest parcel and in other humid forest sites of *F. omissa* flying over the forest canopy in the late afternoon suggest that at least during some portions of the year this species roosts communally.

DIET—In parcel 1 of the RNI d'Andohahela birds were seen to feed on flowers of *Strongyloodon*, *Bakerella*, and *Symponia* and on seeds of *Sloanea*. The stomachs of collected individuals contained some unidentified insects.

BREEDING—A pair of adults obtained on 1 October from the same net and at the time consisted of a male with testes 8×6 mm and a female with a slightly enlarged oviduct, ovarian follicles up to 4 mm in diameter, and no brood patch.

WEIGHT—Female (9), 18.6 ± 1.5 (17.0–21.0) g; male (9), 19.8 ± 1.6 (18.5–22.5) g; combined (18), 19.2 ± 1.6 (17.0–22.5) g.

SOFT PART COLORS—Bill: maxilla black or dusky brown, and mandible black or yellowish brown with paler gonys; legs: pinkish gray or pinkish brown; iris: brown.

Estrildidae

Lonchura nana Madagascar Mannikin

The Madagascar Mannikin was found from the Analalava Forest south along the coast and through the Anosyenne and Vohimena mountains to Petriky and west through the spiny forest to the Mandrare River. This species was occasionally noted in reed beds but generally was a characteristic bird of disturbed habitats, such as rice paddies, pasturelands, dry agricultural fields, and gardens from near sea level to 1150 m. It occasionally penetrated into disturbed areas within intact humid forests. For example, near the Col d'Ambatomanaha we found a flock of seven Madagascar Mannikins in an area of regenerating vegetation associated with a natural landslide. Further, it is found in pockets of upland cleared areas, such as near Vohibaka and Antseva. It is distinctly less common in spiny forest than in more humid areas. Large flocks are occasionally noted, e.g., over 40 in the RP de Berenty in late September (DW).

DIET—The diet is largely seeds. During May this species was observed feeding on the seeds of *Phragmites*.

BREEDING—Adults collected in mid-October and early November were not in breeding condition. A pair was observed building a nest in Tolagnaro on 13 October, and another pair was observed mating at Bealoka on 4 December. Adults were noted feeding free-flying fledglings on 15

October at Manafiafy and on 1 November near Antseva.

WEIGHT—Female (2), 8.5, 9.0 g.

SOFT PART COLORS—Bill: maxilla black, and mandible silver gray; legs: grayish pink; claws: gray; iris: brown.

LOCAL NAMES—*Fodimanta* (Manombo), *tsikinirity* (Manafiafy), *tsimpiririty* (Marosohy), *tsipiritsy* (Berenty).

Analysis and Discussion

General Overview of the Regional Avifauna

Two hundred seventy-eight bird species have been recorded on Madagascar, 204 (73%) of which are known to breed on the island (Langrand, 1990; Langrand & Sinclair, 1994; Langrand & Appert, 1995; Goodman et al., 1996). Prior to the commencement of our field studies in southeastern Madagascar, 74 bird species were known to occur in this region. Currently, 189 species have been documented from southeastern Madagascar. A summary bird list for each of the study sites is presented in Table 6, along with information on habitat association and geographic distribution. More detailed information for birds observed in the RNI d'Andohahela is presented by geographic (Table 7) and elevational (Table 8) distributions.

Of the four littoral forest sites (Manafiafy, Itapera, Mandena, Petriky), Manafiafy ranks the highest in bird species richness (Table 6). The differences in the number of species from the other three littoral forest sites are not pronounced. Likewise, species richness in littoral forest does not differ markedly from that of adjacent humid forest (e.g., Bezavona compared with Mandena, and Manantantely compared with Petriky).

The littoral forest tracts contained no bird species unique to that habitat. The near exception is *Coua gigas*, a species inhabiting the southwestern portion of the island and whose range extends through the littoral forests of southeastern Madagascar as far north as Manafiafy; this species does not occur in adjacent forests on lateritic soils.

The humid forest sites (Marovony, Analalava, Marosohy, RNI d'Andohahela [parcel 1], Bezavona, and Manantantely) had considerably higher species richness than the littoral forest sites. The relatively low species richness of the four littoral forest sites is even more pronounced considering

that all four sites contained aquatic habitats (seashore, coastal lagoons, etc.) that were not present at the six humid forests. The relative richness of the avifauna at 13 forested sites can best be assessed by restricting the analysis to birds that use forest habitats (Table 6). Such species can be divided into those that are forest dwellers (i.e., restricted to areas with closed forest canopy) and those that use mixed forest and open habitats. The four littoral forest sites contain fewer forest-dwelling bird species than do the humid forest sites. Below we comment on inventory conditions and sites and on interesting or unusual features of the avifauna of each surveyed forest.

MANDENA—The habitats surveyed at Mandena include littoral forest, swamp forest, heath (scrub), and marsh (estuary of Lac Ambavarano). At this site, the most comprehensive surveys were conducted within the littoral forests, concentrating mainly on the larger interior blocks where mist nets were erected and dawn censuses were conducted. The other littoral forest parcels were also visited. The forest parcel north of Pointe Evatra was highly degraded.

Particularly noteworthy endemic species included *Lophotibis cristata*, *Anas melleri*, and *Coua gigas*, all three of which appeared to have been relatively common. Despite local hunting pressures on *Lophotibis* in the Mandena area, it was observed at least once per day at the site. *Anas melleri* utilized the aquatic habitats of the area. Relatively high densities of *Coua gigas* were noted in the forested areas.

PETRIKY—Inventories at Petriky concentrated on littoral forests, although further surveys (by boat and on foot) were also made of estuarine aquatic habitats. Particularly interesting endemic species occurring at Petriky included *Coua gigas* and *Ninox superciliaris*. The *Coua* was relatively common in the littoral forest. Petriky represents the easternmost known locality in southern Madagascar for *Ninox*.

MANAFIAFY—Two distinct portions of Manafiafy were intensively surveyed: a block of continuous littoral forest northwest of the village of Manafiafy and a narrow strip of strand forest south of the village and across the Andohafasy River. The habitats in these two areas included littoral forest, swamp forest, heath (scrub), and marsh (waterways of the Andohafasy River). We also visited a number of small remnant and disjunct forest patches along the road leading from the Route Nationale 12a and a few kilometers west of Manafiafy proper.

Particularly noteworthy endemic species occurring in the area included *Lophotibis cristata*, *Anas melleri*, *Coua gigas*, and *Asio madagascariensis*. Relatively high densities of *Coua gigas* were noted, and it was restricted to the littoral forests. Manafiafy is the northernmost locality along the east coast of Madagascar at which this species has been recorded.

MAROSOHY FOREST—The two study sites within the Marosohy Forest were at different elevations (450 m and 750 m) along a trail leading from Antseva to Enakara that forms the northeastern boundary of parcel 1 of the RNI d'Andohahela. The two sites were in lowland forest. Mountain passes (up to nearly 1400 m) and lower agricultural areas at the edge of the reserve were also visited.

Important endemic species occurring in the area were *Lophotibis cristata*, *Mesitornis unicolor*, *Sarothrura insularis*, *Asio madagascariensis*, *Brachypteryx leptosomus*, *B. squamiger*, *Atelornis pittoides*, *Neodrepanis coruscans*, *Randia pseudozosterops*, *Newtonia fanovanae*, and eight members of the Vangidae.

BEZAVONA FOREST—The Bezavona Forest drainage provides a portion of the potable water for Tolagnaro, and there is a pumping station at the base of the valley (see pp. 112–114 for further details). Endemic species occurring in the area of particular interest were *Lophotibis cristata*, *Mesitornis unicolor*, *Asio madagascariensis*, and four members of the Vangidae.

ANALALAVA FOREST—Interesting records of endemic species occurring in this forest included *Lophotibis cristata*, *Mesitornis unicolor*, and three members of the Vangidae.

MAROVONY FOREST—The Marovony Forest contains an extensive lowland area on lateritic soils and is relatively undisturbed. This habitat is under intensive human pressure in southeastern Madagascar, and on a regional basis little of it remains (Green & Sussman, 1990). Noteworthy endemic species occurring in the Marovony Forest are *Lophotibis cristata*, *Mesitornis unicolor*, *Caprimulgus enarratus*, *Philepitta castanea*, and six members of the Vangidae.

MANANTANTELY FOREST—The Manantantely Forest was surveyed between 75 and 200 m, although slopes of up to about 550 m were visited. Particularly interesting endemic species occurring in the area included *Lophotibis cristata*, *Mesitornis unicolor*, *Brachypteryx squamiger*, and four members of the Vangidae.

The Manantantely Forest is particularly note-

TABLE 6. Bird species recorded at each of the study sites in southeastern Madagascar, distributional status, and habitat preferences.

Species	Status ¹	Habitat ²	Site locations ³												
			ME	PE	SL	MA	NH	AL	MO	MN	IT	AK	AN	ANII	BE
<i>Phalacrocorax africanus</i>	N	A													X X
<i>Ixobrychus minutus</i>	N	A	x												
<i>Nycticorax nycticorax</i>	N	A	x	x	x							x		x x	
<i>Ardeola ralloides</i>	N	A		x		x								x x	
<i>Ardeola idae</i>	*	A												x	
<i>Butorides striatus</i>	N	A		x	x							x		x x	
<i>Bubulcus ibis</i>	N	O	x		x	x	x					x		x x	
<i>Egretta ardesiaca</i>	N	A												x	
<i>Egretta dimorpha</i>	(*)	A	x		x	x	x					x		x x	
<i>Egretta alba</i>	N	A	x	x	x	x	x					x	x	x x	
<i>Ardea purpurea</i>	N	A	x	x	x	x	x	x				x		x x	
<i>Ardea cinerea</i>	N	A		x	x					x	x			x x	
<i>Ardea humbloti</i>	(*)	A								x	x			x	
<i>Scopus umbretta</i>	N	O		x		x								x	
<i>Lophotibis cristata</i>	*	F	x		x	x	x	x	x	x	x	x	x	x x	
<i>Phoenicopterus ruber</i>	N	A		x										x x	
<i>Dendrocygna bicolor</i>	N	A												x x	
<i>Dendrocygna viduata</i>	N	A	x	x	x	x	x			x		x		x x	
<i>Sarkidiornis melanotos</i>	N	A					x							x x	
<i>Anas melleri</i>	*	A	x		x										
<i>Anas erythrorhyncha</i>	N	A	x	x	x	x	x					x		x x	
<i>Anas hottentota</i>	N	A		x								x		x x	
<i>Aviceda madagascariensis</i>	*	F				x	x						x	x x	x
<i>Machaeramphus alcinus</i>	N	M												x x	x
<i>Milvus migrans</i>	N	O	x	x	x	x	x	x	x	x	x			x x	
<i>Polyboroides radiatus</i>	*	M	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Accipiter madagascariensis</i>	*	F				x				x				x x	x
<i>Accipiter francesii</i>	(*)	F	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Accipiter henstii</i>	*	F	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Buteo brachypterus</i>	*	M	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Falco newtoni</i>	(*)	O	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Falco zoniventris</i>	*	F									x			x x	x
<i>Falco eleonorae</i>	M	O		x	x									x x	
<i>Falco concolor</i>	M	O			x									x x	
<i>Falco peregrinus</i>	N	M		x		x								x x	
<i>Margaroperdix madagascarensis</i>	*	O	x					x	x		x		x	x x	x
<i>Coturnix coturnix</i>	N	O						x	x		x			x x	
<i>Numida meleagris</i>	N	O	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Mesitornis unicolor</i>	*	F				x	x	x	x	x	x	x		x x	
<i>Turnix nigricollis</i>	*	M	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Dryolimnas cuvieri</i>	(*)	M	x	x	x	x	x	x	x	x	x	x	x	x x	x
<i>Canirallus kioloides</i>	*	F			x			x	x	x	x	x	x	x x	x
<i>Sarothrura insularis</i>	*	F				x						x		x x	
<i>Gallinula chloropus</i>	N	A	x	x										x	
<i>Porphyrio porphyrio</i>	N	A	x		x									x	
<i>Rostratula benghalensis</i>	N	A			x	x								x	
<i>Glareola ocularis</i>	*	O			x	x						x			
<i>Charadrius hiaticula</i>	M	A			x							x			
<i>Charadrius thoracicus</i>	*	A										x			
<i>Charadrius pecuarius</i>	N	A		x	x							x		x	
<i>Charadrius tricollaris</i>	N	A								x				x x	
<i>Charadrius leschenaultii</i>	M	A	x											x x	
<i>Limosa lapponica</i>	M	A	x											x x	
<i>Numenius phaeopus</i>	M	A		x		x					x			x x	
<i>Tringa nebularia</i>	M	A	x	x										x x	
<i>Actitis hypoleucos</i>	M	A	x	x	x	x	x				x		x	x x	
<i>Arenaria interpres</i>	M	A		x							x				
<i>Gallinago macrorhactyla</i>	*	O	x					x							
<i>Calidris alba</i>	M	A		x						x		x			

TABLE 6. *Continued.*

Species	Status ¹	Habitat ²	Site locations ³												
			ME	PE	SL	MA	NH	AL	MO	MN	IT	AK	AN	ANII	BE
<i>Calidris ferruginea</i>	M	A													X
<i>Larus dominicus</i>	N	A			X	X						X			X
<i>Sterna caspia</i>	N	A													X
<i>Sterna dougallii</i>	N	A					X								X
<i>Sterna bergii</i>	N	A			X										
<i>Sterna bengalensis</i>	M	A					X								
<i>Pterocles personatus</i>	*	O										X		X	X
<i>Streptopelia picturata</i>	(*)	M	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Oena capensis</i>	N	M	X	X								X	X	X	X
<i>Treron australis</i>	(*)	F	X	X	X	X	X	X	X		X		X	X	X
<i>Alectroenas madagascariensis</i>	*	F	X		X	X	X	X	X		X		X		
<i>Coracopsis vasa</i>	(*)	F					X					X	X	X	X
<i>Coracopsis nigra</i>	(*)	M	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Agapornis cana</i>	*	M	X			X						X	X	X	X
<i>Cuculus rochii</i>	*	F				X		X	X		X	X	X	X	X
<i>Coua gigas</i>	*	F	X	X	X							X	X	X	X
<i>Coua reynaudii</i>	*	F				X	X	X	X	X					
<i>Coua cursor</i>	*	F										X	X	X	X
<i>Coua ruficeps</i>	*	F										X	X	X	X
<i>Coua cristata</i>	*	F			X							X	X	X	X
<i>Coua caerulea</i>	*	F	X		X	X	X	X	X	X	X		X		
<i>Centropus toulou</i>	(*)	M	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Tyto alba</i>	N	O	X												
<i>Otus rufilatus</i>	(*)	F	X			X	X	X	X	X	X	X	X	X	X
<i>Ninox superciliaris</i>	*	F		X								X			
<i>Asio madagascariensis</i>	*	F			X	X	X								
<i>Asio capensis</i>	N	O													
<i>Caprimulgus madagascariensis</i>	(*)	O	X	X	X	X	X	X	X	X	X	X		X	X
<i>Caprimulgus enarratus</i>	*	F							X				X	X	X
<i>Zonavena grandidieri</i>	(*)	S				X	X	X					X	X	X
<i>Cypsiurus parvus</i>	N	S	X	X	X	X			X	X		X	X	X	X
<i>Apus melba</i>	N	S	X	X	X				X			X	X	X	X
<i>Apus barbatus</i>	N	S			X				X			X	X	X	X
<i>Alcedo vintsioides</i>	(*)	A	X	X	X	X	X	X				X	X	X	X
<i>Ispidina madagascariensis</i>	*	F	X			X	X		X	X		X	X	X	X
<i>Merops superciliosus</i>	N	O	X	X	X	X	X	X	X			X	X	X	X
<i>Eurystomus glaucurus</i>	N	M				X	X	X	X			X	X	X	X
<i>Brachypteryx leptosomus</i>	*	F													
<i>Brachypteryx squamiger</i>	*	F										X			
<i>Atelornis pittoides</i>	*	F					X								
<i>Atelornis crossleyi</i>	*	F													
<i>Leptosomus discolor</i>	(*)	F		X		X	X	X	X	X	X		X	X	X
<i>Upupa epops</i>	N	M	X	X	X							X	X	X	X
<i>Philepitta castanea</i>	*	F				X			X						
<i>Neodrepanis coruscans</i>	*	F					X								
<i>Neodrepanis hypoxantha</i>	*	F						X							
<i>Mirafra hova</i>	*	O	X	X	X	X	X	X	X	X		X	X	X	X
<i>Riparia paludicola</i>	N	S													
<i>Phedina borbonica</i>	(*)	S					X	X				X	X	X	X
<i>Hirundo rustica</i>	M	S		X											
<i>Motacilla flavigaster</i>	*	M	X		X	X	X	X	X	X			X	X	X
<i>Coracina cinerea</i>	(*)	F			X	X	X	X	X	X			X	X	X
<i>Phyllastrephus madagascariensis</i>	*	F				X	X	X	X	X					
<i>Phyllastrephus zosterops</i>	*	F				X		X		X					
<i>Phyllastrephus cinereiceps</i>	*	F					X		X						
<i>Hypsipetes madagascariensis</i>	N	M	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Copsychus albospecularis</i>	*	M		X	X	X	X	X	X	X	X	X	X	X	X
<i>Saxicola torquata</i>	N	O	X	X	X	X	X	X	X	X					
<i>Pseudocossyphus sharpei</i>	*	F													
<i>Acrocephalus newtoni</i>	*	A												X	X

TABLE 6. *Continued.*

Species	Status ¹	Habitat ²	Site locations ³												
			ME	PE	SL	MA	NH	AL	MO	MN	IT	AK	ANI	ANII	BE
<i>Nesillas lantzii</i>	*	M	?	x								x	?	?	?
<i>Nesillas typica</i>	(*)	M			x	x	x	x	x	x	x	x	x	x	x
<i>Thamnornis chloropetoides</i>	*	M											x	x	x
<i>Cisticola cherina</i>	*	O	x	x	x	x		x	x		x	x	x	x	x
<i>Dromaeocercus brunneus</i>	*	F					x						x		
<i>Randia pseudozosterops</i>	*	F					x						x		
<i>Cryptosylvicola randrianasoloi</i>	*	F											x		
<i>Newtonia amphichroa</i>	*	F			x	x	x	x	x	x	x	x	x	x	x
<i>Newtonia brunneicauda</i>	*	F		x	x	x	x	x	x	x	x	x	x	x	x
<i>Newtonia archboldi</i>	*	F										x	x	x	x
<i>Newtonia fanovanae</i>	*	F				x						x			
<i>Neomixis tenella</i>	*	M	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Neomixis viridis</i>	*	F				x	x					x	x	x	x
<i>Neomixis striatigula</i>	*	F				x			x			x	x	x	x
<i>Hartertula flavoviridis</i>	*	F				x	x					x			
<i>Pseudobias wardi</i>	*	F				x						x			
<i>Terpsiphone mutata</i>	(*)	F	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Oxylabes madagascariensis</i>	*	F				x	x		x	x		x			
<i>Crossleyia xanthophrys</i>	*	F											x		
<i>Mystacornis crossleyi</i>	*	F					x	x	x	x			x		
<i>Nectarinia souimanga</i>	(*)	M	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Nectarinia notata</i>	(*)	M	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Zosterops maderaspata</i>	(*)	F	x			x	x	x	x	x	x	x	x	x	x
<i>Calicalicus madagascariensis</i>	*	F				x	x	x	x	x			x		
<i>Schetba rufa</i>	*	F			x	x		x	x	x	x		x		
<i>Vanga curvirostris</i>	*	F	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Xenopirostris xenopirostris</i>	*	F										x	x	x	x
<i>Xenopirostris polleni</i>	*	F				x						x			
<i>Falculea palliata</i>	*	F					x					x	x	x	x
<i>Leptopterus viridis</i>	*	F					x			x		x	x	x	x
<i>Leptopterus chabert</i>	*	M				x			x	x	x	x	x	x	x
<i>Cyanolanius madagascarinus</i>	(*)	M	x			x	x		x	x		x	x	x	x
<i>Hypositta corallirostris</i>	*	F				x	x		x	x		x			
<i>Tylas eduardi</i>	*	F				x						x			
<i>Dicrurus forficatus</i>	(*)	M	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Corvus albus</i>	N	O	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Hartlaubius auratus</i>	*	M	x			x	x	x	x	x			x		
<i>Acridotheres tristis</i>	I	O		x	x	x		x	x	x	x	x	x	x	x
<i>Ploceus nelicourvi</i>	*	F				x	x	x	x	x	x	x	x	x	x
<i>Ploceus sakalava</i>	*	F										x	x	x	x
<i>Foudia madagascariensis</i>	*	M	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Foudia omissa</i>	*	F	x			x				x		x	x	x	x
<i>Lonchura nana</i>	*	O	x	x	x	x	x	x	x		x		x	x	x
Total number of species at each site			60	59	67	100	57	58	67	37	57	52	87	85	99
Percentage of species endemic to Madagascar			37	22	28	53	51	48	54	60	33	50	66	38	41
Percentage of species restricted to region			61	45	54	77	88	81	81	97	60	79	89	61	63
Percentage of species nesting on Madagascar but not endemic			34	45	33	20	12	17	18	3	28	19	10	30	31
Percentage of species that are migrants to area			5	5	12	1	0	0	0	0	11	0	0	4	5
Percentage of species introduced to Madagascar			0	2	2	1	0	2	2	0	2	2	0	1	1

¹ * = endemic to Madagascar, (*) = endemic to region (Madagascar, Comoros, Mascarenes & Seychelles), M = migrant, N = nesting on Madagascar but not endemic to region, I = introduced.

² A = aquatic (including seashore), F = forest dwelling, O = open country, M = mixed forest and open country, S = aerial foraging.

³ ME = Mandena Forest, PE = Petriky Forest, SL = Manafay Forest, MA = Marosohy Forest, NH = Bezavona or Nahampoana Forest, AL = Analalava Forest, MO = Marovony Forest, MN = Manantantely Forest, IT = Itapera, AK = Ankapoky Forest, ANI = RNI d'Andohahela (parcel 1), ANII = RNI d'Andohahela (parcel 2), BE = RP de Berenty.

TABLE 7. Avifaunal composition of study sites in the RNI d'Andohahela.

Site	Total	Endemic to Madagascar	Number (%) of species			
			Endemic to Malagasy region	Obligate forest species	Migrants	Introduced
Andohahela (parcel 1)						
440 m	60	38 (63)	56 (95)	40 (67)	0	0
810 m	65	43 (66)	61 (94)	43 (66)	0	0
1200 m	62	42 (68)	58 (94)	42 (68)	0	0
1500 m	47	30 (64)	44 (94)	36 (77)	0	0
1875 m	37	23 (62)	34 (92)	24 (65)	0	0
Overall	87	58 (67)	78 (90)	52 (69)	0	0
Andohahela (parcel 2)	85	35 (42)	55 (65)	23 (28)	4 (5)	1 (1)

worthy for several reasons. It is positioned at the southern limit of the Vohimena Mountains and represents the southernmost large parcel of humid forest on the island. The Manantantely Forest is located at 24°59'S; thus it is south of the Tropic of Capricorn and, at least based on latitude, is out of the tropical zone. This forest is clearly tropical in structure and floristic components and is one of the southernmost "tropical" humid forests in the Old World.

ITAPERÁ FOREST—The habitats surveyed included the littoral forest, heath (scrub), and aquatic systems (associated with Lac Mananivo). The greatest effort was concentrated in the extant littoral forest, where mist nets were erected and dawn censuses were conducted. Particularly interesting endemic species found in the area included *Lophotibis cristata*, *Charadrius thoracicus*, and *Coua gigas*. Relatively high densities of *C. gigas* were noted in the area, and this species was restricted to the littoral forests.

ANKAPOKY FOREST—The Ankapoky Forest was the only site extensively studied during the QIT project in the spiny forest region. Of all the other QIT sites surveyed, Petriky is the closest to Ankapoky in both distance and floristic communities, although the flora of Petriky Forest is a transitional one between the eastern humid forest and spiny forest. Noteworthy endemic species occurring in the area include *Falco zoniventris*, four sympatric species of *Coua*, *Newtonia archboldi*, and six species of Vangidae.

RNI D'ANDOHAHELA (PARCEL 1)—The eastern slopes of the RNI d'Andohahela contain intact to pristine forest from approximately 400 to 1950 m. Our elevational transect of this forest included five sites along these slopes centered at 440, 810, 1200, 1500, and 1875 m. This region is rich in eastern humid forest species and marks the south-

ern limit in the distribution of many species. Within the elevational transect, there was little proportional variation between zones in percentage of the species endemic to Madagascar, species endemic to the region, or species that are forest dwelling (Tables 7, 8). The reserve has a rich avifauna, and particularly noteworthy endemic species included *Asio madagascariensis*, *Caprimulgus enarratus*, all four humid forest species of Brachypteraciidae, both species of *Neodrepanis*, *Randia pseudozosterops*, the recently described *Cryptosylvicola randrianasoloi*, and nine species of Vangidae.

RNI D'ANDOHAHELA (PARCEL 2)—this parcel, composed largely of spiny forest region, contains an avifauna distinctly different from that of parcel 1, although the two sites are separated by only a few kilometers. Interesting endemic species occurring in the area included *Falco zoniventris*, four sympatric species of *Coua*, *Newtonia archboldi*, and six species of Vangidae.

RÉSERVE PRIVÉE DE BERENTY—Although this privately owned reserve is small (about 250 ha), 98 species of birds have been recorded there. The reserve is composed of spiny forest and gallery forest. The bird list is extensive because of the work conducted by MP over the course of several years and because numerous ecotourists and bird-watchers visit the site. This site, parcel 2 of the RNI d'Andohahela, and Ankapoky share many faunistic aspects.

Relative Densities of Birds Based on Mist-netting

Mist nets were used to assess relative densities of ground-dwelling and lower understory birds at most of the sites visited. There was considerable

TABLE 8. Distribution of bird species in the Réserve Naturelle Intégrale d'Andohahela. The elevational zones listed in the first five columns are along the 1995 transect between Eminiminy and Pic Trafonaomby.

Species	Parcel 1					Other sites	Parcel 2
	440 m	810 m	1200 m	1500 m	1875 m		
<i>Phalacrocorax africanus</i>						*	
<i>Nycticorax nycticorax</i>						*	
<i>Ardeola ralloides</i>						*	
<i>Ardeola idae</i>						*	
<i>Bubulcus ibis</i>						*	
<i>Butorides striatus</i>						*	
<i>Egretta ardesiaca</i>						*	
<i>Egretta dimorpha</i>						*	
<i>Egretta alba</i>						*	
<i>Ardea purpurea</i>						*	
<i>Ardea cinerea</i>						*	
<i>Scopus umbretta</i>						*	
<i>Lophotibis cristata</i>	*	*					
<i>Dendrocygna bicolor</i>						*	
<i>Dendrocygna viduata</i>						*	
<i>Sarkidiornis melanotos</i>						*	
<i>Anas erythrorhyncha</i>						*	
<i>Aviceda madagascariensis</i>		*				*	
<i>Milvus migrans</i>						*	
<i>Polyboroides radiatus</i>						*	*
<i>Accipiter henstii</i>	*	*					
<i>Accipiter francésii</i>	*	*		*		*	*
<i>Buteo brachypterus</i>	*	*	*	*	*		*
<i>Falco newtoni</i>						*	
<i>Falco zoniventris</i>						*	
<i>Falco eleonorae</i>						*	
<i>Falco concolor</i>						*	
<i>Margaroperdix madagascarensis</i>						*	*
<i>Numida meleagris</i>						*	
<i>Turnix nigricollis</i>						*	
<i>Dryolimnas cuvieri</i>	*						
<i>Canirallus kioloides</i>	*	*	*			*	
<i>Sarothrura insularis</i>		*	*	*			
<i>Gallinula chloropus</i>							*
<i>Tringa nebularia</i>						*	
<i>Actitis hypoleucos</i>						*	
<i>Pterocles personatus</i>						*	
<i>Streptopelia picturata</i>	*	*	*	*	*		*
<i>Oena capensis</i>						*	
<i>Treron australis</i>						*	
<i>Alectroenas madagascariensis</i>	*	*	*	*	*		*
<i>Coracopsis vasa</i>	*	*	*	*	*		*
<i>Coracopsis nigra</i>	*	*	*	*	*		*
<i>Agapornis cana</i>							*
<i>Cuculus rochii</i>	*	*	*	*	*		*
<i>Coua gigas</i>							*
<i>Coua reynaudii</i>	*	*	*	*	*		*
<i>Coua cursor</i>							*
<i>Coua ruficeps</i>							*
<i>Coua cristata</i>							*
<i>Coua caerulea</i>	*	*	*	*		*	
<i>Centropus toulou</i>	*	*	*	*			*
<i>Otus rutilus</i>	*	*	*	*			*
<i>Ninox superciliaris</i>							*
<i>Asio madagascariensis</i>	*	*	*				*
<i>Caprimulgus madagascariensis</i>							*
<i>Caprimulgus enarratus</i>						*	
<i>Zoonavena grandidieri</i>	*	*	*		*		*

TABLE 8. *Continued.*

Species	Parcel 1					Other sites	Parcel 2
	440 m	810 m	1200 m	1500 m	1875 m		
<i>Cypsiurus parvus</i>	*	*	*				*
<i>Apus melba</i>	*	*	*			*	*
<i>Apus barbatus</i>	*	*	*	*	*	*	*
<i>Alcedo vintsioides</i>	*	*					*
<i>Ispidina madagascariensis</i>	*	*	*				
<i>Merops superciliosus</i>						*	*
<i>Eurystomus glaucurus</i>				*			*
<i>Brachypteryx leptosomus</i>	*	*	*	*			
<i>Brachypteryx squamiger</i>	*						
<i>Atelornis pittoides</i>			*				
<i>Atelornis crossleyi</i>		*	*	*	*		
<i>Leptosomus discolor</i>	*	*	*	*	*		*
<i>Upupa epops</i>							*
<i>Philepitta castanea</i>	*	*	*	*	*		
<i>Neodrepanis coruscans</i>		*					
<i>Neodrepanis hypoxantha</i>			*	*	*		
<i>Mirafra hova</i>						*	*
<i>Riparia paludicola</i>						*	
<i>Phedina borbonica</i>		*	*			*	
<i>Motacilla flavigaster</i>	*	*	*			*	
<i>Coracina cinerea</i>	*	*	*	*	*		*
<i>Phyllastrephus madagascariensis</i>	*	*	*				
<i>Phyllastrephus zosterops</i>	*	*	*				
<i>Phyllastrephus cinereiceps</i>		*	*	*	*		
<i>Hypsipetes madagascariensis</i>	*	*	*	*	*		
<i>Copsychus albospecularis</i>	*	*	*				
<i>Saxicola torquata</i>						*	
<i>Pseudocossyphus sharpei</i>	*	*	*	*	*		
<i>Acrocephalus newtoni</i>							*
<i>Nesillas lantzii</i>							?
<i>Nesillas typica</i>	*	*	*	*	*		
<i>Thamnornis chloropetoides</i>							
<i>Cisticola cherina</i>						*	
<i>Dromaeocerus brunneus</i>			*	*	*		
<i>Randia pseudozosterops</i>	*	*					
<i>Cryptosylvicola randrianasoloi</i>		*	*	*	*		
<i>Newtonia amphichroa</i>	*	*	*	*	*		
<i>Newtonia brunneicauda</i>	*	*	*	*	*		
<i>Newtonia archibaldi</i>							
<i>Newtonia fanovanae</i>	*						
<i>Neomixis tenella</i>	*	*	*				
<i>Neomixis viridis</i>	*	*	*	*	*		
<i>Neomixis striatigula</i>	*	*	*				
<i>Hartertula flavoviridis</i>	*	*	*				
<i>Pseudobias wardi</i>	*	*	*				
<i>Terpsiphone mutata</i>	*	*	*				
<i>Oxylabes madagascariensis</i>	*	*	*	*		*	
<i>Crossleyia xanthophrys</i>		*	*	*			
<i>Mystacornis crossleyi</i>	*	*	*				
<i>Nectarinia souimanga</i>	*	*	*				
<i>Nectarinia notata</i>	*	*	*				
<i>Zosterops maderaspatana</i>	*	*	*	*			
<i>Calicalicus madagascariensis</i>	*	*	*				
<i>Schetba rufa</i>	*	*					
<i>Vanga curvirostris</i>	*		*				
<i>Xenopirostris xenopirostris</i>							
<i>Xenopirostris polleni</i>	*	*	*				
<i>Falculea palliata</i>							
<i>Leptopterus viridis</i>	*	*	*	*			

TABLE 8. *Continued.*

Species	Parcel 1					Other sites	Parcel 2
	440 m	810 m	1200 m	1500 m	1875 m		
<i>Leptopterus chabert</i>	*	*	*				*
<i>Cyanolanius madagascarinus</i>	*	*	*	*			
<i>Hypositta corallirostris</i>	*						
<i>Tylas eduardi</i>	*	*	*	*	*		
<i>Dicrurus forficatus</i>	*	*	*	*	*		*
<i>Corvus albus</i>							*
<i>Hartlaubius auratus</i>	*	*	*				
<i>Acridotheres tristis</i>							*
<i>Ploceus nelicourvi</i>	*	*	*	*	*		*
<i>Ploceus sakalava</i>							*
<i>Foudia madagascariensis</i>					*		*
<i>Foudia omissa</i>	*	*	*	*	*		
<i>Lonchura nana</i>							*
Total number of species	60	65	62	47	37		85

variation between sites in the number of species and individuals captured (Table 9). The results are analyzed by forest type.

There were considerable differences between the number of species and individuals captured in the littoral forests of Petriky, Mandena, Manafia-

fy, and Itapera (Table 10). At Manafiafy netting was conducted at two sites: strand forest and littoral forest. In the strand forest the capture rate was almost 10 times greater than in the littoral forest, although the number of species captured was approximately the same. At both sites the canopy height was approximately the same, and thus these differences may reflect absolute numbers of understory birds at each site. In the forests of Petriky and Itapera few individuals or species were captured. Compared with the strand forest of Manafiafy, the species richness and relative densities at Itapera were remarkably low. Another comparison of these two areas comes from dawn censuses, during which 20 species were recorded at Manafiafy and 11 species were recorded at Itapera (Table 11). On the basis of these results it appears that the relative density and species richness in Itapera are distinctly lower than at Manafiafy. These two sites are only a few kilometers from one another and are part of the same botanical formation.

Considerably more species and four times as many individuals were captured at the spiny forest site of Ankapoky (Table 9). Ankapoky had the highest capture rate of any forest surveyed. The mist net capture rate of 4.4 individuals per net-day is inflated by the capture of 35 *Ploceus sakalava*, a species locally restricted to this biome and moving in flocks at the time of the survey. Further, 18 *Oena capensis* were netted. These two species alone made up over half of the individuals captured. Even with these two species removed from the total net captures, about two individuals

TABLE 9. Summary of mist-netting results at study sites in southeastern Madagascar. Capture rate is defined as the number of individual birds captured per net-day.

Site	Forest type	Num- ber of spec- ies cap- tu- red	Total num- ber of 12-m net- days	Total num- ber of birds	Cap- ture rate
Mandena	Littoral	12	110	24	0.22
Petriky	Littoral	3	80	3	0.04
Manafiafy	Littoral				
North forest		11	240	18	0.08
Strand		13	46.5	42	0.90
Itapera	Littoral	2	38.5	3	0.08
Marosohy	Humid				
425 m		9	50	36	0.72
750 m		20	63	79	1.25
Bezavona	Humid	11	14	24	1.71
Analalava	Humid	9	31	24	0.77
Marovony	Humid	22	110	82	0.75
Manantantely	Humid	14	32	37	1.16
Ankapoky	Spiny	17	22	96	4.36
Andohahela	Humid				
440 m		12	50	38	0.76
810 m		21	50	61	1.22
1200 m		17	50	48	0.96
1500 m		16	50	61	1.22
1875 m		9	50	41	0.82

TABLE 10. Mist-netting summary in the littoral forests of Petriky, Mandena, Manafiafy, and Itapera and spiny forest of Ankapoky. Entries are number of individuals captured/capture rate.¹

Species	Littoral (0–20 m)				Spiny	
	Petriky	Mandena	Manafiafy strand	Manafiafy north forest	Itapera	Ankapoky (70–100 m)
<i>Accipiter francesii</i>	1/0.01	2/0.02	1/0.02	3/0.01		
<i>Falco newtoni</i>						1/0.05
<i>Streptopelia picturata</i>		1/0.01	2/0.04	1/0.004		2/0.09
<i>Oena capensis</i>						18/0.82
<i>Treron australis</i>				1/0.02		
<i>Agapornis cana</i>						3/0.14
<i>Coua cristata</i>						1/0.05
<i>Otus rutilus</i>		1/0.01				
<i>Caprimulgus madagascariensis</i>			5/0.11			2/0.09
<i>Alcedo vintsioides</i>			1/0.02	1/0.004		
<i>Ispidina madagascariensis</i>		1/0.01				
<i>Upupa eops</i>						2/0.09
<i>Hypsipetes madagascariensis</i>		1/0.01	7/0.15	1/0.004		2/0.09
<i>Copsychus albospecularis</i>			2/0.04	1/0.004		8/0.36
<i>Cisticola cherina</i>						1/0.05
<i>Newtonia brunneicauda</i>			5/0.11		1/0.03	4/0.18
<i>Newtonia archboldi</i>						1/0.05
<i>Neomixis tenella</i>		1/0.01	3/0.06	2/0.008		
<i>Neomixis striatigula</i>						1/0.05
<i>Terpsiphone mutata</i>	1/0.01	1/0.01	2/0.04	3/0.01		
<i>Nectarinia souimanga</i>	1/0.01	9/0.08	7/0.15	4/0.02	2/0.05	5/0.23
<i>Nectarinia notata</i>		2/0.02	5/0.11	1/0.004		
<i>Vanga curvirostris</i>		2/0.02	1/0.02	2/0.008		
<i>Leptopterus chabert</i>						5/0.23
<i>Dicrurus forficatus</i>		1/0.01		1/0.004		
<i>Ploceus sakalava</i>						35/1.60
<i>Foudia omissa</i>		2/0.02				
Total net-days	80	110	46.5	240	38.5	22
Total number captured	3	24	42	20	3	96
Total number of species	3	12	13	11	2	17

¹ Capture rate is the number of individuals per species per net-day.

were captured per net-day, a capture rate higher than at any other site in southeastern Madagascar (Table 9). The canopy of the Ankapoky Forest is distinctly lower than in any other Forest we studied, and thus the height of the total flight corridor of birds was compressed. The high rate of net captures may not be entirely a measure of high density but rather may reflect our sampling of a greater portion of the forest cross section relative to canopy height.

In lowland humid forests there was less variation in the number of species and individuals captured with mist nets (Tables 9, 12, 13). At the sites below 100 m (Bezavona, Analalava, Marovony, Manantantely), the number of birds captured per net-day ranged from 0.75 in the Marovony Forest to 1.71 in the Bezavona Forest. Although the Marovony Forest had the lowest capture rate, more species were captured there than at the other three

sites; this discrepancy is related to differences in the number of net-days at each site.

Along the elevational transect of the humid forest zone (parcel 1) of the RNI d'Andohahela standardized mist-netting samples were obtained (Table 13). At each site (440, 810, 1200, 1500, and 1875 m) 10 nets, 12 m long, were left in place for five consecutive days. Over the five zones there was little variation in capture rate, ranging from 0.76 at 440 m to 1.22 at both 810 and 1500 m. The number of species netted in each zone was variable, with a peak at 810 m (21 species) and a low at 1875 m (nine species). This pattern is similar to that on a parallel transect conducted along the eastern humid forest slopes of the RNI d'Andringitra, where the highest netting success was in the 720–810-m zone and then success declined as a function of elevation (Goodman & Putnam, 1996). However, in the RNI d'Andringitra

TABLE 11. Comparison of bird contact frequencies in the littoral forests of Manafiafy and Itapera based on dawn censuses. Relative density is measured as the number of individuals heard and observed per 100 m of trail. Total length of trails was not standardized.

Species	Manafiafy			Itapera		
	Relative density	(Range)	Number of days ¹	Relative density	(Range)	Number of days ²
<i>Lophotibis cristata</i>	0.1		1	0.13	(0.1–0.2)	3
<i>Accipiter francesii</i>	0.4		1			
<i>Dryolimnas cuvieri</i>	0.15	(0.1–0.2)	2			
<i>Streptopelia picturata</i>	0.16	(0.1–0.3)	3	0.2		1
<i>Treron australis</i>	0.1		1			
<i>Coracopsis nigra</i>	0.27	(0.1–0.4)	6			
<i>Coua gigas</i>	0.20	(0.1–0.4)	4	0.13	(0.1–0.2)	4
<i>Coua caerulea</i>	0.30	(0.1–0.5)	4	0.1		1
<i>Centropus toulou</i>	0.47	(0.3–0.7)	6	0.2	(0.2–0.2)	2
<i>Merops superciliosus</i>	0.15	(0.1–0.2)	2	0.1		1
<i>Coracina cinerea</i>	0.20	(0.2–0.2)	2			
<i>Hypsipetes madagascariensis</i>	0.19	(0.1–0.4)	6	0.2		1
<i>Copsychus albospecularis</i>	0.10	(0.1–0.1)	4	0.1		1
<i>Newtonia brunneicauda</i>	0.25	(0.1–0.6)	6	0.3	(0.1–0.6)	3
<i>Neomixis tenella</i>	0.69	(0.2–1.3)	7			
<i>Terpsiphone mutata</i>	0.13	(0.1–0.2)	4			
<i>Nectarinia souimanga</i>	1.16	(0.7–1.7)	7	1.3	(1.1–1.4)	4
<i>Nectarinia notata</i>	0.1		1			
<i>Vanga curvirostris</i>	0.28	(0.1–0.6)	5	0.4	(0.3–0.6)	3
<i>Dicrurus forficatus</i>	0.15	(0.1–0.2)	2			

¹ Number of mornings out of 7 the species was recorded.

² Number of mornings out of 4 the species was recorded.

there was no sample in the 400-m zone and the 710-m site included partially open and disturbed forest with some human hunting pressure. The number of species captured in the RNI d'Andohahela and RNI d'Andringitra at 810-m sites were 21 and 13, respectively, at 1200 m and 1210 m were 17 and 13, respectively, and at 1500 m and 1625 m were 16 and 15, respectively.

Birds also were netted in the Marosohy Forest at 425 and 750 m, which is along the northern edge of the RNI d'Andohahela (parcel 1) and is part of the same large tract of forest. The nets at the 425-m site in the Marosohy Forest captured 10 species and 36 individuals during 50 net-days, whereas at 440 m in the RNI d'Andohahela 12 species and 38 individuals were captured during 60 net-days. At the 750-m site in the Marosohy Forest 20 species and 79 individuals were captured in 63 net-days, whereas at 810 m in the RNI d'Andohahela 21 species and 61 individuals were captured in 50 net-days. Thus, there were broad similarities between these two sites in relative numbers of individuals and species captured in nets.

When sites with netting data are combined by forest type, capture rates (weighted average,

range) are: littoral and strand forest, 0.17, 0.04–0.9; spiny forest, 4.36; and humid forest, 1.10, 0.72–1.71. Thus, the spiny forest had the highest capture rate of any forest type, and more under-story birds were captured in the taller humid forests than in the littoral forests.

Elevational Distribution of Birds

The species richness of forest birds declined with elevation in parcel 1 of the RNI d'Andohahela (Table 8), as expected from bird studies in other tropical areas (Terborgh, 1971, 1977; Prigogine, 1980; Beehler, 1982; Goodman et al., 1995). Comparative data from other elevational transects in Madagascar, at the RS d'Anjanaharibe-Sud and the RNI d'Andringitra, at both of which the elevational samples started at about 800 m, also show a similar pattern of a decline in species number above this elevation. The 440-m sample in the RNI d'Andohahela had five fewer species than the 800-m sample. Because this difference was relatively small and because forests below 400 m are largely destroyed (which may influence species richness at this site),

TABLE 12. Mist-netting summary in the lowland humid forests of Marosohy, Bezavona, Analalava, Marovony, and Manantantely. Entries are number of individuals captured/capture rate.¹

Species	Marosohy (425 m)	Marosohy (750 m)	Bezavona (75 m)	Analalava (40 m)	Marovony (50 m)	Manantantely (~100 m)
<i>Accipiter francesii</i>		1/0.015	1/0.07		1/0.01	
<i>Streptopelia picturata</i>		1/0.015	1/0.07			1/0.03
<i>Otus rutilus</i>		2/0.03				2/0.06
<i>Caprimulgus madagascariensis</i>					3/0.03	
<i>Caprimulgus enarratus</i>					1/0.01	
<i>Alcedo vintsioides</i>		1/0.015				
<i>Ispidina madagascariensis</i>	1/0.02	4/0.06	1/0.07		1/0.01	1/0.03
<i>Merops superciliosus</i>					1/0.01	
<i>Brachypteryx leptosomus</i>		1/0.015				
<i>Philepitta castanea</i>	9/0.18	11/0.17			1/0.01	
<i>Neodrepanis coruscans</i>		1/0.015				
<i>Phyllastrephus madagascariensis</i>	4/0.08	11/0.17		8/0.26	15/0.14	7/0.22
<i>Phyllastrephus zosterops</i>	3/0.06	3/0.05		1/0.03		
<i>Hypsipetes madagascariensis</i>	2/0.04	5/0.08	6/0.43		6/0.05	7/0.22
<i>Copsychus albospecularis</i>	5/0.10	9/0.14	2/0.14	2/0.06	15/0.14	5/0.16
<i>Nesillas typica</i>					2/0.02	
<i>Newtonia amphichroa</i>					1/0.01	
<i>Newtonia brunneicauda</i>		1/0.015		1/0.03	1/0.01	5/0.16
<i>Newtonia fanovanae</i>	1/0.02					
<i>Hartertula flavoviridis</i>	2/0.04					
<i>Terpsiphone mutata</i>	7/0.14	10/0.16		6/0.19	9/0.08	6/0.05
<i>Oxylabes madagascariensis</i>						
<i>Mystacornis crossleyi</i>		1/0.015	1/0.07		2/0.02	
<i>Nectarinia souimanga</i>		2/0.03	1/0.07	1/0.03	2/0.02	1/0.03
<i>Nectarinia notata</i>				3/0.10	3/0.03	
<i>Zosterops maderaspatana</i>	2/0.04	6/0.1	1/0.07	2/0.06	4/0.04	3/0.09
<i>Calicalicus madagascariensis</i>						1/0.03
<i>Schetba rufa</i>				3/0.10	1/0.01	
<i>Dicrurus forficatus</i>		1/0.015	1/0.07		1/0.01	2/0.06
<i>Ploceus nelicourvi</i>		8/0.13	7/0.14		5/0.01	1/0.03
<i>Foudia madagascariensis</i>				2/0.14	1/0.01	2/0.06
<i>Foudia omissa</i>						2/0.06
Total net-days	50	63	14	31	110	32
Total number captured	36	79	24	31	82	37
Total number of species	10	19	11	11	22	14

¹ Capture rate is the number of individuals per species per net-day.

we do not consider this evidence of a mid-elevation peak in species richness (*sensu* Janzen et al., 1976; McCoy, 1990; Olson, 1994).

The only site in Madagascar that has been studied in a manner comparable to that of the RNI d'Andohahela is the RNI de Zahamena, with data from 500 to 1500 m. At this site, the 500-m sample was by far the most species rich (Hawkins, unpubl.). In contrast, the 440-m sample at RNI d'Andohahela had five fewer species than the sample at 800 m. Differences in the bird community between the RNI d'Andohahela and RNI de Zahamena provide an additional explanation for the slightly lower species richness of lowland forest at Andohahela. The only bird species significantly more abundant in the RNI d'Andohahela

than in the RNI de Zahamena were *Crossleyia xanthophrys* and *Xenopirostris polleni*. Both species were most common in the RNI d'Andohahela above 800 m. In contrast, five species were recorded in the RNI de Zahamena that were not found in the RNI d'Andohahela (*Euriorchis astur*, *Coua serriana*, *Phyllastrephus tenebrosus*, *Oriolia bernieri*, and *Euryceros prevostii*). All were recorded in the RNI de Zahamena only at 500 m, and elsewhere in their ranges they are unknown or very rare above 1000 m (Thorstrom & Watson, 1994; Hawkins et al., in press). Thus, the major difference in the bird community between parcel 1 of the RNI d'Andohahela and sites to the north is in the lowland species. Most of these species are not known south of the region south of

TABLE 13. Mist-netting summary of birds captured along an elevational gradient in the RNI d'Andohahela (parcel 1). Recaptures are not included. Entries are number of individuals captured/capture rate.¹

Species	Elevation (m)				
	440	810	1200	1500	1875
<i>Streptopelia picturata</i>				2/0.04	
<i>Otus rutilus</i>		1/0.02			
<i>Alcedo vintsioides</i>		3/0.06			
<i>Ispidina madagascariensis</i>	2/0.04	5/0.10	1/0.02		
<i>Brachypteryx squamiger</i>	1/0.02				
<i>Atelornis pittoides</i>			2/0.04		
<i>Philepitta castanea</i>	4/0.08	5/0.10	7/0.14	10/0.20	2/0.04
<i>Neodrepanis coruscans</i>		3/0.06	1/0.02		
<i>Neodrepanis hypoxantha</i>				4/0.08	4/0.08
<i>Motacilla flavigaster</i>		3/0.06			
<i>Phyllastrephus madagascariensis</i>	8/0.16	1/0.02	3/0.06		
<i>Phyllastrephus zosterops</i>	4/0.08	3/0.06	7/0.14		
<i>Phyllastrephus cinereiceps</i>			1/0.02	4/0.08	
<i>Hypsipetes madagascariensis</i>	2/0.04	4/0.08	1/0.02		
<i>Copsychus albospecularis</i>	6/0.12	5/0.10		2/0.04	
<i>Pseudocossyphus sharpei</i>		2/0.04		1/0.02	4/0.08
<i>Nesillas typica</i>		1/0.02	1/0.02	8/0.16	8/0.16
<i>Newtonia amphichroa</i>			4/0.08	8/0.16	1/0.02
<i>Newtonia brunneicauda</i>					1/0.02
<i>Hartertula flavoviridis</i>				2/0.04	
<i>Terpsiphone mutata</i>	6/0.12	7/0.14	4/0.08	3/0.06	
<i>Oxylabes madagascariensis</i>		1/0.02	1/0.02	4/0.04	
<i>Crossleyia xanthophrys</i>			3/0.06	1/0.02	
<i>Mystacornis crossleyi</i>	1/0.02				
<i>Nectarinia souimanga</i>	1/0.02			1/0.02	12/0.24
<i>Zosterops maderaspatana</i>	1/0.02	9/0.018		1/0.02	6/0.12
<i>Leptopeterus viridis</i>		1/0.02			
<i>Cyanolanius madagascariensis</i>		1/0.02			
<i>Tylas eduardi</i>		1/0.02	3/0.06		
<i>Dicrurus forficatus</i>		3/0.06	1/0.02		
<i>Ploceus nelicourvi</i>	2/0.04	1/0.02	2/0.04	3/0.06	
<i>Foudia omissa</i>		1/0.02	6/0.12	7/0.14	3/0.06
Total net-days	50	50	50	50	50
Total number captured	38	61	48	61	41
Total number of species	12	21	17	16	9

¹ Capture rate is the number of individuals per species per net-day, not including recaptures.

the PN de Ranomafana, and their absence from the RNI d'Andohahela reflects a decrease in humid forest bird species richness with increasing latitude.

Utilization of Sisal Plantations by Forest Birds

During forest surveys in the gallery forests of Malaza and Bealoka along the Mandrare River within the spiny forest zone in 1984 and 1985 it was noticed that many birds made use of sisal (*Agave rigida*) during flowering and fruiting. These two forests are now small remnants of the former natural habitat and are surrounded by

thousands of hectares of sisal plantations. In its sterile form sisal provides little sustenance or cover for most birds (Fig. 15), but when flowering it becomes a sought-after resource, both for food (directly by providing flowers, pollen, and nectar and indirectly by attracting insects) and as favored perching sites from which hunting, displaying, mating, and sunning may take place.

Agave inflorescences are tall and over a period of a few months may grow to over 6 m in height. An *Agave* plant may take 20–30 years to accumulate enough carbohydrates to support one season of flowering (Crawford, 1989). In a commercial setting, plantations are usually large enough and with sufficient different generations of plants to provide a substantial and predictable food re-



FIG. 15. Young sisal plantation near Amboasary-Sud. A relatively high diversity of birds use such areas, but only when the plants are in flower. (Photograph by T. S. Schulenberg.)

source from year to year even though each plant flowers only once in its lifetime. However, the usefulness of sisal to forest birds as a resource is greater when close to forest.

Sisal plantations border the western boundaries of the Malaza Forest and the Bealoka Forest, which is 7 km farther north along the Mandrare River. Monthly data were collected by MP on birds utilizing sisal at both sites between May 1984 and April 1985. Perimeter transects were walked one day per month for 1 year. All birds seen or heard, as well as height off ground, type of activity, distance from observer, and substrate preference (i.e., perched on inflorescence or among leaves), were recorded.

At the Malaza Forest the 1-km perimeter trail bordering the sisal was used for the transect. The survey in this forest started in June 1984. Transects were walked in the morning and evening until September, after which transects were walked only in the morning. A total of 20.5 hours, covering 15 km, was spent surveying the Malaza sisal plantation. At Bealoka, a sisal plantation bordered the forest along the com-

plete length of the 1.5-km trail. The survey here commenced in May 1984 and followed the same procedure during the period of the study. Totals of 25.5 km of trail and 33 hours of observations were accrued at this site.

Twenty-nine species of birds were recorded in the sisal plantations during the survey, and a further 10 species were observed in the sisal at other times. Of these 39 species, 25 (63.9%) are considered forest-dwelling species (Fig. 16). Using the results from both forests, feeding was one of the most common activities. Thirty-three percent of birds observed during the transects were feeding from sisal flower heads either directly or indirectly (Table 14). At Malaza however, most birds were observed perched on the sisal and vocalizing. Feeding we defined as birds engaged in the process of consuming at the moment of the observation. Birds undertaking "food searches" were not considered to be feeding.

The height, stability, and food offered by the inflorescences was an important enticement for birds to visit sisal. Collectively (at Malaza and Bealoka) only 7.8% of birds were observed in the

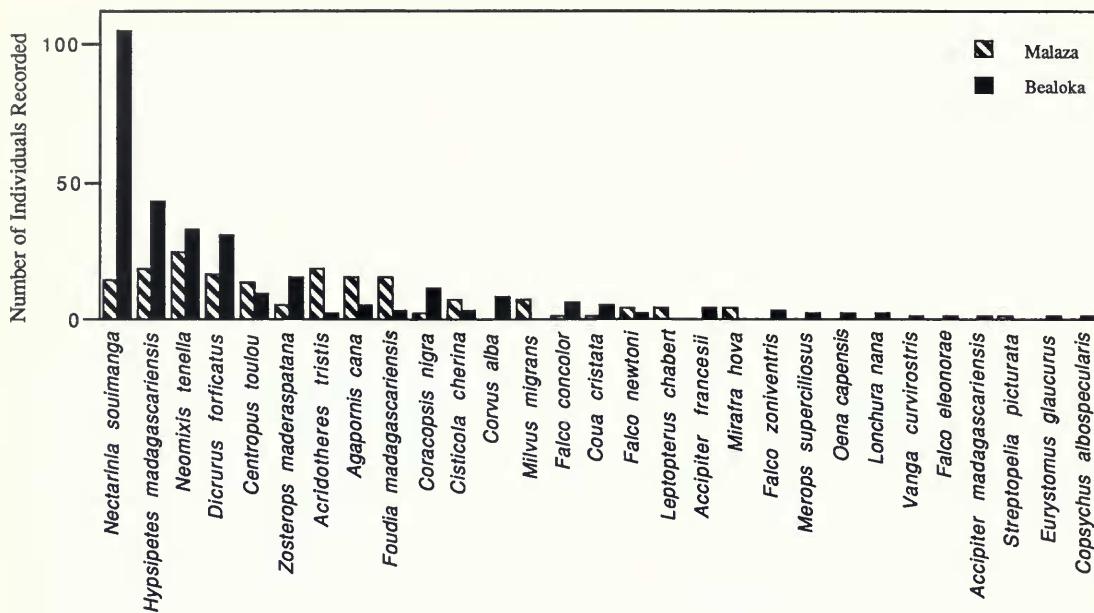


FIG. 16. Total number of individuals per species recorded in sisal plantation along survey transects at the edge of the Malaza and Bealoka forests. Species recorded utilizing sisal but not observed during transect surveys included *Buteo brachypterus*, *Falco peregrinus*, *Coracopsis vasa*, *Coua gigas*, *Upupa epops*, *Newtonia brunneicauda*, *Neomixis striatigula*, *Terpsiphone mutata*, *Leptopterus viridis*, and *Ploceus sakalava*.

TABLE 14. Sisal use by birds¹ adjacent to the Malaza and Bealoka forests.

Months	Total number of birds	Total diversity	Perched on inflorescence	Perched on foliage	Perched vocalizing	Perched feeding	Average height (m)
1984							
May	—/82	—/10	—/78	—/3	—/35	—/33	—/4.5
June	13/62	3/8	6/62	7/0	11/14	0/22	3.4/4.7
July	19/29	5/10	19/29	0/0	7/6	7/10	5.1/4.7
August	60/40	9/9	57/40	3/0	28/4	26/30	5.8/4.6
September	17/20	6/7	16/20	1/0	5/3	9/8	4.3/4.1
October	29/17	10/5	26/17	2/0	11/1	6/0	3.7/4.8
November	2/11	2/6	1/11	1/0	0/2	0/3	4.5/5.2
December	17/12	6/7	13/8	4/4	6/3	0/0	3.7/3.5
1985							
January	2/10	1/4	2/6	0/4	2/3	0/0	6.0/3.8
February	2/3	2/2	0/3	2/0	2/0	0/0	1.8/3.6
March	4/2	2/2	0/2	4/0	0/0	0/0	0.4/3.4
April	4/6	2/2	3/6	1/0	5/1	0/0	4.2/5.0
Total	169/294	18/25	143/282	25/11	77/72	48/106	3.9/4.3
Total by percentage			84.6/95.9	14.8/3.7	45.6/24.5	28.4/36.1	
Combined results	463	29 ²	425	36	149	154	4.1
Combined results by percentage			91.8	7.8	32.2	33.3	

¹ Presented as number at Malaza/number at Bealoka.

² An additional 10 species were observed in sisal outside of count periods.

foliage, and at Bealoka only 3.7% were observed in the foliage (Table 14). Although eight species of birds were observed perched among the sisal foliage, 50% of observations were represented by only two species: *Centropus toulou* and *Cisticola cherina*. The former is a common but rather secretive skulking bird that benefits from the cover the sisal leaves provide. The latter is an inhabitant of the grass layer and roadside verges; it was seen only in sisal foliage and never up high on the flower stalk.

Direct comparisons of sisal utilization along the two transects are difficult. At Malaza along the shorter transect the sisal was only one or two plants wide along the entire survey route and directly abutted the forest periphery. At Bealoka extensive sisal fields of hundreds of hectares border the forest and the two habitats are separated by a 10-m-wide road, which creates a barrier between forest and plantation that some forest birds may not cross. The rewards are greater for the birds of Bealoka than for those of Malaza because of the more extensive sisal fields. Nevertheless, birds perched in sisal at Bealoka presumably were more exposed to predation, which may partly explain why 80% of all observations in sisal at this site were less than 30 m from the forest edge.

In 1984 sisal was flowering between May and October. Although the results presented in Table 14 suggest a decline in feeding after October, this is just as much a consequence of demand by local people, who use the stems for fence poles, as it is a period of flower degeneration. Following the removal of the inflorescence stalks there was a distinct change in bird activity. The frequency of birds declined substantially, and at Malaza more birds were seen in foliage than in inflorescences. During the last 4 and 5 months 50% of all birds were recorded or seen over 30 m from the forest, and these birds were mostly "open country" species, i.e., *Falco concolor*, *Centropus toulou*, *Nectarinia souimanga*, *Hypsipetes madagascariensis*, *Cisticola cherina*, *Dicrurus forficatus*, *Acridotheres tristis*, and *Foudia madagascariensis*. The most accessible flower stalks, those generally closest to trails and roadways, were felled, and the removal of this resource caused an instant reduction in the number of birds along the transect.

Apart from perching and feeding in flower heads and using the foliage for cover, birds occasionally exploited plant sap from the sisal's growing stem. In July and August 1984, perhaps the period of maximum flowering that year and also during the middle of the dry season, *Lemur*

catta at Malaza would climb halfway up the flower spikes and chew holes into the sides of the stem to feed on the rising sap. These holes were worked on daily until hollows within the stem held considerable quantities of liquid sap. This resource was exploited by *Hypsipetes*, *Neomixis tenuella*, *Nectarinia souimanga*, and *Zosterops*. At times the sunbirds were seen drinking from the same holes in sisal stems as beetles, wasps, and flies.

In conclusion, sisal's usefulness to birds is maximized when it grows adjacent to forest. A noticeable decline in bird species richness in sisal occurs as a function of distance from the forest edge. Sisal is principally utilized by birds during inflorescence growth, when it provides food and elevated perches. Sisal in its sterile state is of little appeal to forest birds and provides only a temporary habitat for some ground-dwelling birds and birds of open country.

Faunistics and Biogeography

Within southeastern Madagascar there is a remarkable change in the climate and flora across the rain shadow caused by the Anosyenne Mountains. Here we examine the faunal affinities of the forest-dwelling bird fauna within southeastern Madagascar in comparison with the bird communities of humid and dry forest sites elsewhere on the island. We define forest-dwelling species as those that occur in forest but are not necessarily forest dependent. Opposite extremes of this definition include the ground-rollers (Brachypteraciidae), which are completely forest dependent, and generalists, such as *Hypsipetes madagascariensis* and *Nectarinia* spp., which occur in a wide variety of habitats, including forest.

We have chosen sites for this analysis that are ornithologically well known and represent a wide range of different forest types (Table 15). To assess the relationships of the regional and extra-limital avifauna, we calculated two different similarity indices for the distribution of breeding birds within forest habitat:

$$\text{Simpson's Index} = \frac{C}{N_1}$$

$$\text{Jaccard's Index} = \frac{C}{N_1 + N_2 - C}$$

where N_1 = the number of species at site 1 (the

TABLE 15. Distribution of resident forest-dwelling birds¹ at well-known sites in the eastern humid forest, spiny bush, and transitional forest. Key to sites: AnI = RNI d'Andohahela (parcel 1), And = RNI d'Andringitra (restricted to humid forest), Ran = PN de Ranomafana, Anl = RS d'Analamazaotra, Anj = RS d'Anjanaharibe-Sud, Mas = proposed PN de Masoala, Mda = Montagne d'Ambre, AnII = RNI d'Andohahela (parcel 2), Ber = RP de Berenty, Bez = RS de Beza Mahafaly, Zom = proposed PN de Zombitse. Entries in brackets denote that the local subspecies is inferred.

Species	Humid forest						Subarid thorn scrub				Transitional
	AnI (400– 1900 m)	And (720– 1625 m)	Ran (750– 1100 m)	Anl (900– 1000 m)	Anj (860– 1950 m)	Mas (0– 1224 m)	Mda (900– 1450 m)	AnII (80– 150 m)	Ber (15– 30 m)	Bez (100– 200 m)	Zom (750– 900 m)
<i>Lophotibis c. cristata</i>	x	x	x	x	x	x	x				
<i>Lophotibis c. urschi</i>								[x]			[x]
<i>Aviceda madagascariensis</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Machaeramphus alcinus</i>						x			x		
<i>Eutriorchis astur</i>				x	x	x					
<i>Polyboroides radiatus</i>	x	x	x	x	x	x		x	x	x	x
<i>Accipiter madagascariensis</i>	x	x	x	x	x	x	x		x	x	x
<i>Accipiter f. francesii</i>	x	x	x	x	x	x	x		x	x	x
<i>Accipiter henstii</i>	x	x	x	x	x	x	x				x
<i>Buteo brachypterus</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Falco n. newtoni</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Falco zoniventris</i>			x	x	x	x		x	x	x	x
<i>Falco peregrinus radama</i>	x	x			x					x	
<i>Mesitornis unicolor</i>	x	x	x	x	x	x					
<i>Turnix nigricollis</i>	x	x				x		x	x	x	x
<i>Dryolimnas c. cuvieri</i>	x		x	x	x	x	x	x	x	x	x
<i>Canirallus k. kioloides</i>	x	x	x	x	x	x	x				
<i>Sarothrura insularis</i>	x	x	x	x	x	x	x				
<i>Pterocles personatus</i>								x	x	x	x
<i>Streptopelia p. picturata</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Oena capensis aliena</i>								x	x	x	x
<i>Treron a. australis</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Alectroenas madagascariensis</i>	x	x	x	x	x	x	x				
<i>Coracopsis v. vasa</i>	x	x	x	x		x	x				
<i>Coracopsis v. drouhardi</i>								[x]	[x]	[x]	[x]
<i>Coracopsis n. nigra</i>	x	x	x	x	x	x	x				
<i>Coracopsis n. libis</i>								[x]	[x]	[x]	[x]
<i>Agapornis c. cana</i>	x	x				x					
<i>Agapornis c. ablactanea</i>								x	x	x	x
<i>Cuculus audeberti</i>		x		x							
<i>Cuculus rochii</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Coua gigas</i>								x	x	x	x
<i>Coua serriana</i>				x	x	x					
<i>Coua reynaudii</i>	x	x	x	x	x	x					
<i>Coua cursor</i>								x	x	x	x
<i>Coua ruficeps olivaceiceps</i>								x	x	x	x
<i>Coua c. cristata</i>			x	x	x	x	[x]				
<i>Coua c. pyropyga</i>								x	x	x	x
<i>Coua caerulea</i>	x	x	x	x	x	x					
<i>Centropus t. toulou</i>	x	x	x	x	x	x		x	x	x	x
<i>Tyto soumagnei</i>				x	x	x	x				
<i>Otus r. rutilus</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Ninox superciliaris</i>						x	x	x	x	x	x
<i>Asio madagascariensis</i>	x	x	x	x		x	x		x	x	x
<i>Caprimulgus enarratus</i>	x	x	x	x	x	x	x				
<i>Zonavena g. grandidieri</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Ispidina m. madagascariensis</i>	x	x	x	x	x	x	x				
<i>Ispidina m. diluta</i>											x
<i>Eurystomus g. glaucurus</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Brachypteryx leptosomus</i>	x	x	x	x	x	x					

TABLE 15. *Continued.*

Species	Humid forest							Subarid thorn scrub			Transi-
	AnI (400– 1900 m)	And (720– 1625 m)	Ran (750– 1100 m)	AnI (900– 1000 m)	Anj (860– 1950 m)	Mas (0– 1224 m)	Mda (900– 1450 m)	AnII (80– 150 m)	Ber (15– 30 m)	Bez (100– 200 m)	Zom (750– 900 m)
<i>Brachypteryx squamiger</i>	x	x			x	x					
<i>Atelornis pittoides</i>	x	x	x	x		x	x				
<i>Atelornis crossleyi</i>	x	x	x	x	x	x					
<i>Leptosomus d. discolor</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Upupa epops marginata</i>							x	x	x	x	x
<i>Philepitta castanea</i>	x	x	x	x	x	x					
<i>Neodrepanis coruscans</i>	x	x	x	x	x	x					
<i>Neodrepanis hypoxantha</i>	x	x		x	x						
<i>Coracina c. cinerea</i>	x	x	x	x	x	x	x				
<i>Coracina c. pallida</i>								x	x	x	[x]
<i>Phyllastrephus m. madagascariensis</i>	x	x	x	x	x	x	x				
<i>Phyllastrephus m. inceleber</i>											x
<i>Phyllastrephus z. zosterops</i>	x	x	x	[x]							
<i>Phyllastrephus z. fulvescens</i>							x				
<i>Phyllastrephus z. maroantsetrae</i>						x					
<i>Phyllastrephus z. andapae</i>					x						
<i>Phyllastrephus apperti</i>											x
<i>Phyllastrephus tenebrosus</i>				x		x					
<i>Phyllastrephus cinereiceps</i>	x	x	x	x	x	x	x				
<i>Hypsipetes m. madagascariensis</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Copsychus a. albospecularis</i>				x	x	[x]					
<i>Copsychus a. pica</i>								x	x	x	x
<i>Copsychus a. inexpectatus</i>	x	x	x	x	x	x					
<i>Pseudocossyphus s. sharpei</i>	x	x	x	x	x	x	x				
<i>Pseudocossyphus s. erythronotus</i>							x				
<i>Pseudocossyphus bensonii</i>											x
<i>Nesillas t. typica</i>	x	x	x	x	x	x	x				
<i>Nesillas lantzi</i>								x	x	x	x
<i>Thamnornis chloropetoides</i>								x	x	x	x
<i>Dromaeocercus brunneus</i>	x	x	x	x	x						
<i>Dromaeocercus sebohmi</i>			x								
<i>Randia pseudozosterops</i>	x	x	x	x	x	x					
<i>Cryptosylvicola randrianasoloi</i>	x	x	x	x	x						
<i>Newtonia amphichroa</i>	x	x	x	x	x	x	x				
<i>Newtonia b. brunneicauda</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Newtonia archboldi</i>								x	x	x	x
<i>Newtonia fanovanae</i>	x				x	x					
<i>Neomixis t. tenella</i>					[x]	x	x				
<i>Neomixis t. debilis</i>										[x]	[x]
<i>Neomixis t. orientalis</i>	x	x	[x]	[x]				[x]	[x]		
<i>Neomixis viridis</i> subsp.	x	x	x	x	x	x					
<i>Neomixis striatigula sclateri</i>	x	x	x	x	x	x					
<i>Neomixis s. pallidior</i>								x	x	x	x
<i>Hartertula flavoviridis</i>	x	x	x	x	x	x					
<i>Pseudobias wardi</i>	x	x	x	x	x	x					
<i>Terpsiphone m. mutata</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Oxylabes madagascariensis</i>	x	x	x	x	x	x	x				
<i>Crossleyia xanthophrys</i>	x	x	x	x	x	x					
<i>Mystacornis crossleyi</i>	x	x	x	x	x	x					
<i>Nectarinia s. souimanga</i>	x	x	x	x	x	x	x				
<i>Nectarinia s. apolis</i>								x	x	x	x
<i>Nectarinia n. notata</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Zosterops m. maderaspata</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Calicalicus madagascariensis</i>	x	x	x	x	x	x	x				x
<i>Schetba r. rufa</i>	x	x	x	x	x	x					

TABLE 15. *Continued.*

Species	Humid forest							Subarid thorn scrub			Transi-
	AnI (400- 1900 m)	And (720- 1625 m)	Ran (750- 1100 m)	AnI (900- 1000 m)	Anj (860- 1950 m)	Mas (0- 1224 m)	Mda (900- 1450 m)	AnII (80- 150 m)	Ber (15- 30 m)	Bez (100- 200 m)	Zom (750- 900 m)
<i>Schetba r. occidentalis</i>											x
<i>Vanga c. curvirostris</i>	x	x	x	x	x	x	x		x	x	x
<i>Vanga c. cetera</i>								x	x	x	x
<i>Xenopirostris xenopirostris</i>								x	x	x	x
<i>Xenopirostris polleni</i>	x	x	x	x		x		x	x	x	x
<i>Falculea palliata</i>								x	x	x	x
<i>Leptopterus v. viridis</i>	x	x	x	x	x	x		[x]	[x]	[x]	[x]
<i>Leptopterus v. annae</i>											
<i>Leptopterus c. chabert</i>	x	x	x	x	x	x	x	x	[x]	[x]	[x]
<i>Leptopterus c. schistocercus</i>								x	[x]	[x]	[x]
<i>Cyanolanius m. madagascarinus</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Oriolia bernieri</i>						x	x				
<i>Euryceros prevostii</i>					x	x	x				
<i>Hypositta corallirostris</i>	x	x		x	x	x					
<i>Tylas e. eduardi</i>	x	x	x	x	x	x	x				
<i>Dicrurus f. forficatus</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Hartlaubius auratus</i>	x	x	x	x	x	x	x				
<i>Ploceus nelicourvi</i>	x	x	x	x	x	x	x				
<i>Ploceus sakalava minor</i>								x	x	x	x
<i>Foudia madagascariensis</i>	x	x	x	x	x	x	x	x	x	x	x
<i>Foudia omissa</i>	x	x	x	x	x	x					

¹ Sources of information: AnI = herein, includes Marofohy Forest; And = Goodman and Putnam (1996); Ran = Nicoll and Langrand (1989), Goodman et al. (1996), Goodman (unpubl.); AnI = Nicoll and Langrand (1989), Langrand and Sinclair (1994), Goodman et al. (1996); Anj = Nicoll and Langrand (1989), Halleux and Goodman (1994), Hawkins et al. (in press); Mas = Nicoll and Langrand (1989), Watson and Strzalkowska (1992), Thorstrom and Watson (1994), Langrand and Sinclair (1994); MDA = Langrand (1995), Andrianarimisa (1994), Andrianarimisa and Goodman (unpubl.), B. Freed (pers. comm.), S. M. Goodman (unpubl.); AnII = herein, Nicoll and Langrand (1989); Ber = herein, Nicoll and Langrand (1989); Bez = Nicoll and Langrand (1989), Ratsirarson (1996), Goodman (unpubl.); Zom = Goodman et al. (1994a).

smaller fauna), N_2 = the number of species at site 2, and C = the number of species common to both sites. The coefficients from these indices were used in a cluster algorithm (PHYLIP, using the Fitch-Margoliash method with contemporary tips written by J. Felsenstein).

Further, to demonstrate two different aspects of the biogeographic relationships and species turnover across the island, and specifically across the pluviometric fault, we calculated the two indices using two different species concepts: the biological species (Mayr, 1942, 1992) and the phylogenetic species (McKittrick & Zink, 1988) concepts. In the context of these analyses, distinct geographic forms (subspecies) of a taxon are combined as a single taxonomic unit of a biological species and separated as different taxonomic units of a phylogenetic species. We have chosen the latter approach to emphasize presumed genetic

isolation between distinct populations of the eastern humid forest and those of the dry areas to the west. The coefficients of the analyses for the biological species are presented in Table 16 and those of the phylogenetic species are presented in Table 17.

AFFINITIES OF THE REGIONAL AVIFAUNA—All four analyses show that the avifaunas of the humid forests and the dry forests are distinctly different from one another and that sites of comparable forest type form close clusters (Fig. 17), regardless of geographic distance. On a regional basis the two habitat types within the RNI d'Andohahela (which in southeastern Madagascar exemplify differences between the wet and dry forests), although only separated by about 5 km of ground distance (our study sites within these parcels are about 30 km apart), have the most biogeographically distinct avifaunas of any sites cho-

TABLE 16. Faunal similarity indices using a biological species concept of resident forest-dwelling birds of several well-known sites. Above the diagonal is Jaccard's Index and below the diagonal is Simpson's Index.¹ Locality abbreviations follow Table 15.

AnI	And	Ran	AnI	Anj	Mas	Mda	AnII	Ber	Bez	Zom	
AnI	—	0.93	0.89	0.84	0.88	0.79	0.58	0.36	0.43	0.38	0.36
And	0.96	—	0.86	0.86	0.78	0.77	0.54	0.36	0.43	0.39	0.45
Ran	0.97	0.96	—	0.87	0.82	0.77	0.64	0.37	0.39	0.40	0.48
AnI	0.92	0.94	0.97	—	0.86	0.83	0.60	0.34	0.43	0.37	0.44
Anj	0.95	0.88	0.95	0.93	—	0.83	0.55	0.32	0.36	0.34	0.41
Mas	0.90	0.88	0.92	0.92	0.91	—	0.61	0.39	0.45	0.41	0.48
Mda	0.91	0.87	0.92	0.94	0.89	0.96	—	0.45	0.49	0.47	0.53
AnII	0.70	0.70	0.66	0.68	0.66	0.77	0.66	—	0.84	0.90	0.76
Ber	0.71	0.71	0.64	0.73	0.64	0.75	0.68	1.00	—	0.89	0.79
Bez	0.74	0.72	0.70	0.80	0.66	0.75	0.64	0.98	1.00	—	0.78
Zom	0.63	0.74	0.74	0.74	0.70	0.79	0.72	0.96	0.89	0.94	—

¹ See text (p. 105) for definitions of indices.

sen for this analysis. The bird fauna of the eastern humid forest, a region extending nearly 1,200 km between parcel 1 of the RNI d'Andohahela and the RS d'Anjanaharibe-Sud, is more homogeneous than that of the few kilometers separating parcel 1 and parcel 2 of the RNI d'Andohahela. The differences in the avifaunas between the two parcels within the RNI d'Andohahela can be explained by two factors: species turnover and geographic variation.

Ninety-three forest-dwelling bird species are known from the two parcels. Of these, 78 species occur in parcel 1, of which 46 (59%) are unknown from parcel 2. Forty-seven species are documented in parcel 2, of which 14 species (30%) have not been recorded in parcel 1. This relatively high level of species turnover accounts for the biogeographic differences between these two sites. These 93 forest-dwelling biological species correspond

to 104 phylogenetic species; analyses based on phylogenetic species are closely comparable to those based on biological species.

Nonetheless reliance on the biological species concept may underestimate levels of genetic disjunctions across the faunal boundary. We strongly suspect that genetic studies of taxon pairs (conspecific subspecies/phylogenetic species) across the ecotone would show that in most cases these populations are genetically distinct with little to no gene flow between them. For example, *Nesillas typica* formerly was treated as a polytypic biological species, with *N. t. typica* found in the humid areas in southeastern Madagascar and *N. t. lantzii* found in the dry areas to the west. Recent genetic studies have demonstrated that these populations are distinct and should be treated as separate species (Schulenberg et al., 1993). Several other species might show parallel patterns of differentiation

TABLE 17. Faunal similarity indices using a phylogenetic species concept of resident forest-dwelling birds of several well-known sites. Above the diagonal is Jaccard's Index and below the diagonal is Simpson's Index.¹ Locality abbreviations follow Table 15.

AnI	And	Ran	AnI	Anj	Mas	Mda	AnII	Ber	Bez	Zom	
AnI	—	0.93	0.89	0.84	0.85	0.73	0.51	0.23	0.25	0.22	0.21
And	0.96	—	0.86	0.86	0.78	0.71	0.47	0.21	0.33	0.24	0.25
Ran	0.97	0.96	—	0.87	0.76	0.71	0.56	0.20	0.24	0.24	0.26
AnI	0.92	0.94	0.97	—	0.80	0.77	0.53	0.20	0.27	0.23	0.25
Anj	0.91	0.88	0.90	0.89	—	0.81	0.51	0.20	0.21	0.21	0.23
Mas	0.86	0.85	0.88	0.88	0.90	—	0.58	0.22	0.27	0.25	0.27
Mda	0.83	0.79	0.85	0.87	0.85	0.92	—	0.27	0.31	0.27	0.29
AnII	0.49	0.47	0.43	0.45	0.45	0.49	0.47	—	0.84	0.87	0.75
Ber	0.48	0.50	0.45	0.52	0.43	0.52	0.49	1.00	—	0.86	0.77
Bez	0.46	0.50	0.48	0.48	0.46	0.52	0.44	0.96	0.98	—	0.78
Zom	0.37	0.47	0.47	0.47	0.46	0.51	0.47	0.94	0.88	0.94	—

¹ See text (p. 105) for definitions of indices.

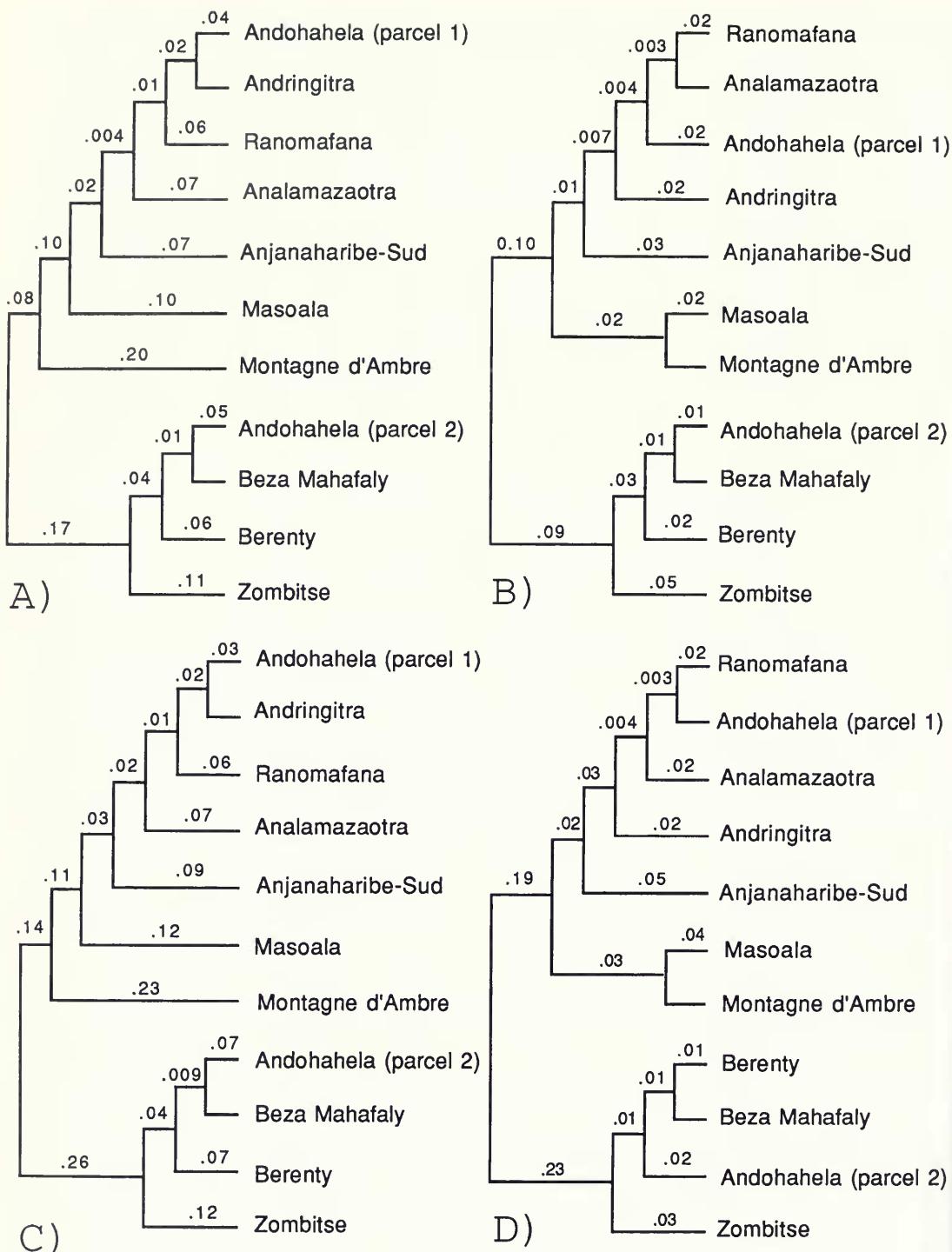


FIG. 17. Cluster analysis of faunal similarity of resident forest birds found at various sites on Madagascar. Coefficients derived from Jaccard's and Simpson's (Tables 16, 17) indices were used. Jaccard's Index with biological species (A), Simpson's Index with biological species (B), Jaccard's Index with phylogenetic species (C), and Simpson's Index with phylogenetic species (D). See text (p. 105) for definitions of indices.

(e.g., *Agapornis cana*, *Neomixis striatigula*). However, this pattern is repeated among the regional avifauna and among numerous other types of vertebrates.

Despite the current sharpness of faunal turnover at this ecotone, the faunal boundary was not constant over recent geological time. There have been considerable fluctuations in the regional biological communities. The only known Holocene subfossil site in the region is the Grotte d'Andrahomana, located about 50 km west-southwest of Tolagnaro, in a region that is now just west of the pluviometric fault and now largely has a spiny forest flora. The site, which was excavated in the early portion of this century (Grandidier, 1902; Goodman & Rakotondravony, 1996), contained a rich assortment of vertebrate material. Among these remains were many species of extinct and extant lemurs (Walker, 1967), some of which have affinities to the humid forest or to the dry forest (Godfrey et al., 1997). The type of *Microgale decaryi* was excavated from this cave (Grandidier, 1928); a recent revision of this genus has shown that *M. decaryi* is a synonym of *M. principula* (MacPhee, 1987), a species that is widespread in the eastern humid forest. Further, remains of an extinct rodent, *Hypogeomys australis*, whose sole extant congener lives in dry forest, have been excavated from the cave (Grandidier, 1903). Radiocarbon dating of *Hypogeomys* remains from the Grotte d'Andrahomana show that these animals existed in the region $4,440 \pm 60$ years ago (Goodman & Rakotondravony, 1996).

BIOGEOGRAPHIC AFFINITIES OF THE LOCAL AVIFAUNA IN COMPARISON WITH OTHER WELL-KNOWN SITES ON THE ISLAND—On a broader, island-wide scale, several other interesting comparisons emerged in the biogeographic analysis. Within the Jaccard's indices (Figs. 17A, C) the humid forest sites are arranged along a latitudinal gradient from south to north. For both biological and phylogenetic species concepts, the distances in the branching pattern between the sites of the RNI d'Andohahela (parcel 1) north to the RS d'Anjanaharibe-Sud are small, which reflects a broadly distributed eastern humid forest avifauna. On a finer scale, the latitudinal component reflects an increase in species richness along a south-north gradient. In the Simpson's analyses (Figs. 17B, D), Montagne d'Ambre and the Masoala Peninsula have been placed on a separate branch, presumably reflecting a different avifaunal composition. Montagne d'Ambre is an isolated mountain, with humid forest on the northeastern and

eastern sides and dry forest along the other flanks. The avifauna of the mountain is depauperate in comparison with other humid forest sites and possesses elements of dry forest. In general, the Masoala Peninsula has a rich avifauna, and its clustering with Montagne d'Ambre is presumably related to the absence at these two sites of several species of broadly distributed eastern humid forest birds (*Neodrepanis hypoxantha*, *Dromaeocercus brunneus*, *Cryptosylvicola randrianasoloi*, *Randia pseudozosterops*, *Hartertula flavoviridis*, *Crossleyia xanthophrys*).

Within the dry and transitional forest analyses for both indices and both species concepts, there is a consistent relationship. All of the four sites, RNI d'Andohahela (parcel 2), RP de Berenty, RS de Beza Mahafaly, and the Zombitse Forest, are closely clustered, with short distances between the nodes and branches. Although several of these sites are separated by considerable distances (e.g., RNI d'Andohahela [parcel 2] and the Zombitse Forest are separated by about 300 km), there is a group of species that makes up the regional avifauna. Moreover, the birds of Zombitse Forest, which is floristically transitional between the east and west (Morat, 1973; Du Puy et al., 1994) and structurally closer to dry forest, are much more closely allied to the dry forest than to the humid forest. However, in the dendograms the Zombitse Forest is the outlier of the dry forest sites.

On the basis of these analyses of the biogeographic relationships of the birds known from well-documented sites on the island, there appear to be at least two distinct avifaunas, one of dry areas and one of wet areas. Abiotic factors (e.g., annual precipitation) and biotic factors (e.g., floristic communities) best explain the separation of these two communities. Distance is of little consequence in explaining this pattern, and sites separated by a few kilometers (e.g., parcels 1 and 2 of the RNI d'Andohahela) have vastly different avifaunas.

Conservation Problems in Southeastern Madagascar

By far the greatest threat to bird populations in southeastern Madagascar is posed by habitat destruction, especially of forested habitats. This problem affects all forest types throughout the region and is driven by a variety of social factors. Here we describe in greater detail the history of some sites at which we have worked in the region

and the forces we have identified that, if unchecked, will lead to the loss or degradation of most of what little forest remains.

THE FATE OF THE REMAINING LOWLAND FOREST: THE CASE OF ANALALAVA AND MAROVONY—Older people in the village of Soavary (at the southern edge of the Marovony Forest) remember from their childhoods, 40–60 years ago, vast stretches of forest on the south side of the Ambolomitsaky River reaching all the way to Manantenina. In the past 50 or so years this forest has been reduced to a fraction of its previous size, and now the Analalava Forest is a relatively small, isolated forest fragment (Fig. 18)—much smaller than shown on the map (1:100,000) of the area published in June 1961 by the Institut National de Géodésie et Cartographie. Even during the interval between our visits in November 1989 and November 1990 there was a detectable reduction in the size of the Analalava Forest. Most of this change was not a result of forest cutting but rather of the encroachment on the forest of fires in surrounding grasslands (see Salomon, 1993). However, the Marovony Forest, farther to the north, appears to have remained relatively intact. Because the forest structure and flora of the Marovony Forest and the remaining portion of the Analalava Forest are almost identical (Lowry & Faber-Langendoen, 1991) and the two forests were until recent times essentially continuous, the question can be posed, What effect have forest fragmentation and isolation had on the avifauna of these two areas?

Approximately equal effort was spent on bird surveys at Analalava (13 days) and at Marovony (10 days). No migrant species was observed at either site, and one species of introduced bird was noted at both sites. Nine bird species (eight of which are endemic to Madagascar) found in the Marovony Forest were not recorded in the Analalava Forest, and only one forest-dependent bird species (*Phyllastrephus zosterops*) was found in the Analalava Forest and not in the Marovony Forest. Given our assumption that the forests once had similar avifaunas, and the current differences in species richness between these sites, it appears that within a short period of time a number of local extinctions have occurred in the Analalava Forest that are presumably related to its reduction in size and increasing isolation. A similar pattern has been found in a series of forested fragments in the RS d'Ambohitantely (Langrand & Wilmé, 1997).

Bird densities, as measured by mist-netting success, also were higher in the Marovony Forest

than in the Analalava Forest (Table 18). When only the first 33 net-days of the Marovony Forest netting results are used, basically equal to the number tabulated from the Analalava Forest, the capture rate on average still remains slightly higher than that at the Analalava Forest (31 birds in 33 net-days = 0.94 capture rate).

Little remains of the once extensive humid forests of eastern Madagascar (Green & Sussman, 1990), particularly the forests below 100 m, and very little of such lowland forest is included within the present reserve system (Nicoll & Langrand, 1989). Without question the Marovony Forest is the largest remaining tract of such forest south of Fianarantsoa, and indeed it may be the largest remaining lowland forest south of Maroantsetra.

During our stay in the Marovony Forest we had several discussions with local people about the present state of local forests and the effects of deforestation. The president of the local committee in Soavary observed that the people of this community had watched the forests of Analalava disappear over the past two generations and that they wanted to safeguard the Marovony Forest as a managed resource for future generations, specifically as a source for important medicinal plants and trees for canoes. The president specifically asked us about the mechanisms needed and procedures to follow to accomplish this. Thus, given the biotic importance of the Marovony Forest, with regard to the amount of lowland forest within the existing reserve system, and the eagerness of local people to protect and manage this forest, such a project should be considered one of the highest priorities for conservation action in southeastern Madagascar.

THE DESTRUCTION OF THE BEZAVONA (NAHAMPOANA) FOREST, AN IMPORTANT WATERSHED FOR TOLAGNARO, OVER THE COURSE OF 3 YEARS—Tolagnaro is the largest town in southeastern Madagascar. The greatest part of the fresh water for the city comes from surrounding lakes and mountain streams. The Bezavona Forest was the watershed for a small stream that in 1989 supplied 12–15% of the water used in Tolagnaro (JIRAMA, Tolagnaro, pers. comm.). Along one of the middle slopes of the Bezavona Forest a concrete embankment acted as a dam across a small river. A pipeline carried water from this reservoir down through the forest to the Lakandava water-processing plant and then to Tolagnaro.

When we first visited the Bezavona Forest in November 1989 most of the forest between the water station and the dam was in relatively good



FIG. 18. Remaining portion of the Analalava Forest after vast areas were cleared over the past few decades. (Photograph by M. Pidgeon.)

condition. Between the end of the 1989 and beginning of the 1990 field seasons, however, a number of woodcutters moved into the Bezavona Forest. Sections of the forest between the JIRAMA station and the dam were partially logged. Trails in the nearby forest were expanded, and new trails

were cut into areas within the Bezavona drainage. The acceleration of forest destruction and the number of people working the Bezavona Forest for wood products was probably related to a recently imposed ban on woodcutting in the Mandena Forest, a few kilometers away. Traditionally,

TABLE 18. Comparison of bird-netting capture rate in lowland humid forest at Analalava and Marovony.

Species	Analalava (net-days = 31)		Marovony (net-days = 71)		Marovony (first 33 net-days)	
	Total captured	Capture rate	Total captured	Capture rate	Total captured	Capture rate
<i>Accipiter francesii</i>			1	0.01	1	0.03
<i>Caprimulgus enarratus</i>			1	0.01	1	0.03
<i>Ispidina madagascariensis</i>			1	0.01	1	0.03
<i>Phyllastrephus madagascariensis</i>	8	0.26	18	0.25	10	0.30
<i>Phyllastrephus zosterops</i>	1	0.03				
<i>Hypsipetes madagascariensis</i>			3	0.04	1	0.03
<i>Copsychus albospecularis</i>	2	0.06	14	0.20	8	0.24
<i>Nesillas typica</i>			2	0.03	1	0.30
<i>Newtonia amphichroa</i>			1	0.01		
<i>Newtonia brunneicauda</i>	1	0.03	1	0.01		
<i>Terpsiphone mutata</i>	6	0.19	8	0.11	5	0.15
<i>Oxylabes madagascariensis</i>			6	0.08		
<i>Mystacornis crossleyi</i>			2	0.03		
<i>Nectarinia souimanga</i>	1	0.03	3	0.04	2	0.06
<i>Nectarinia notata</i>	3	0.10				
<i>Zosterops maderaspata</i>	2	0.06	3	0.04	2	0.06
<i>Schetba rufa</i>	3	0.10	1	0.01		
<i>Dicrurus forficatus</i>			1	0.01		
<i>Ploceus nelicourvi</i>			5	0.07		
Total numbers	27	0.87	70	0.99	31	0.94

Mandena provided significant amounts of fuel-wood and charcoal for Tolagnaro, and wood removal and opportunistic hunting have significantly altered the integrity of this forest (Fig. 19). Once restrictions and forest guards were put in place at Mandena, woodcutters simply moved over to the Bezavona Forest. On several occasions officials working for JIRAMA and DEF in Tolagnaro were briefed on the destruction of the Bezavona Forest. We were told that forest guards had been assigned to the Bezavona Forest.

When Bezavona was visited on 25 December 1992, the vast majority of the forest between the embankment and the station had been partially to totally destroyed. Numerous fires were still smoldering. Furthermore, above the embankment a relatively flat area of several hectares had been totally cleared. An attendant at the Lakandava Station mentioned that the quality of the water had diminished, that they were having problems with sedimentation, and that soon it would be necessary to relocate the station to another watershed. Thus, in the course of 3 years an important forest block was lost that represented a large fraction of the fresh water for Tolagnaro.

Two aspects of this situation need to be discussed in some detail. The first is that the amount of remaining intact forest in the region is small, and it will not be a simple matter to find an ap-

propriate site to relocate the station. Further, such a shift is expensive and the money may have been better put toward forest protection. The second point is that in economic terms it was possible to put some clear value to the importance of protecting this forest. Without water, Tolagnaro simply dries up. The ramifications of this would be increased hardships for the local population, the economy, and the governmental and private-sector infrastructure of southeastern Madagascar. Factors more difficult to define, such as biodiversity, aesthetics, and so forth, do not enter into the rationale or justification of why it was important to have protected the Bezavona Forest. Alas, officials did not extend protection to this forest, and it is not clear if, in the long term, any forest in the region can be conserved when government officials fail to appreciate the value of intact forests and do not act to protect them as charged by law.

THE FATE OF THE SPINY FOREST BIOME OF SOUTHERN MADAGASCAR—The spiny forest biome of southern Madagascar, a forest type with up to 95% plant endemism (Perrier de la Bathie, 1936), is probably the region's most important biome in terms of biological uniqueness and endemism. Unfortunately, extensive areas of spiny forest have been destroyed, from a mixture of commercial gain for a few and the needs for basic subsistence for many.



FIG. 19. Charcoal pit in the Mandena Forest. (Photograph by T. S. Schulenberg.)

Since the 1920s much of the vegetation of the Mandrare River Valley, an area of considerable species richness within the subdesert biome, has been lost. This process was initiated by several colonial families, first for timber and some mining, and subsequently large tracts were cleared in the valley for sisal plantations. The sisal factory at Berenty village, near the Malaza Forest, was established in 1930 (O'Connor, 1987). The Malaza Forest was designated as a private reserve in 1936, when it was fenced and patrolled by guards. In the 1980s this reserve became well known as the RP de Berenty. Most of the remaining forest blocks of gallery vegetation along the lower Mandrare River are isolated from each other, are in a highly degraded condition, and are surrounded by sisal plantations and cleared forest. Although the exploitation of spiny forest has been in place for decades, new areas are still being converted to sisal plantations. Sisal monoculture is insensitive to the natural environment (Fig. 15). It is an old legacy that shows the devastating and lasting effects of indiscriminate exploitation and lack of causality associated with the destruction of this particularly fragile spiny forest environment.

Madagascar is a country of approximately 12 million people, the vast majority of whom depend largely on wood and charcoal fuels for household use and for small industry. A considerable portion of this fuel is obtained from the hardwoods and saplings of the spiny forest region of the island. Charcoal production and timber exploitation by individuals and entrepreneurs is the most serious threat to this forest type.

To put the extent of utilization in perspective, 95% of household fuel needs in 1990 across Madagascar were met by wood (FAO, 1993). Up to the beginning of the 1980s, 5,000 ha of forest was cleared annually to provide Toliara with charcoal (Andrianabololona, 1979). Between 1990 and 1991 fuelwood and charcoal production increased 446% and 353%, respectively (Office National de l'Environnement, 1994).

Most of the human population of southern Madagascar, especially those living in the environs of the spiny forest, live in a rural environment. Traditionally, exploitation of wood was restricted to meeting simple daily needs. Much of the current destructive practice of clear-felling timber to make charcoal was introduced from

charcoal workers migrating into the area from the regions around Toliara, where they effectively exhausted the more accessible forests along the major routes.

Much of the timber exploitation, particularly for planks of *fantsihilotra* (*Alluaudia procera*) and for the production of charcoal, to a varying degree is controlled by merchants who contract out the labor to local people. The huge increase in recent years in charcoal production south of parcel 2 of the RNI d'Andohahela is partly a consequence of demand by entrepreneurs in Toliara and other provincial towns for *katrafay* charcoal. *Katrafay* is a forest hardwood but is also a generic term for natural forest charcoal. Such charcoal is preferred to *kininina* (produced from *Eucalyptus*) for its longer and hotter burning properties.

There are other threats to the spiny forest, and most are exacerbated by wood exploitation. Fire poses a threat only when colonizing shrubs and grasses provide a herbaceous layer in degraded forest. In its natural state, the flora of the spiny forest, with its succulent characteristics, remains largely fire resistant. The several million cattle and goats that inhabit the south are destructive to the vegetation because of trampling and consumption of both herbaceous and woody plants on a massive scale.

Today, spiny forest in pristine or relatively intact condition is perpetually under threat. East of the Mandrare River only a few areas within and north of parcel 2 of the RNI d'Andohahela show the floral and structural heterogeneity of pristine spiny forest, and even within these areas it is rare to find 60-year-old *Alluaudia procera* that have escaped the pressures of selective logging. Because much of the spiny forest is free from large-scale burning and intensive agriculture, it is particularly saddening to see it pillaged for fuel. Certainly the local fuel needs of southeastern Madagascar and probably further afield could be met by the full use of governmental eucalyptus plantations, which produce a usable charcoal. Antananarivo and other major towns on the Central High Plateau satisfy their charcoal needs largely with eucalyptus. Now is the critical period to put in place programs that provide the cultural and logistical means to switch charcoal production from *katrafay* to *kininina*. It is a sad state of affairs when eucalyptus in the south of the country is treated with more reverence and protected by stronger laws than is Madagascar's most unique floral biome.

Acknowledgments

The field studies of SMG and TSS during 1989 and 1990 in southeastern Madagascar were largely funded by QIT Madagascar Minerals Ltd. For permits to conduct this research we are grateful to the Direction des Eaux et Forêts, particularly Georges Rakotonarivo and Céleste Ravaoarioromanga. Other participants in the QIT-Fer surveys included G. Ken Creighton, Ron Crombie, Patrick Daniels, Claire Hemingway, Ron Nussbaum, Ernestine Raholimavo, Haja Nirina Rakotomanana, Henri Jonah Ratsimbazafy, Chris Raxworthy, Jean Claude Razafimahaimodison, and Jim Ryan. Numerous people in the Tolagnaro region provided help with permits, logistics, transportation, etc., but we would particularly like to acknowledge Alain Bouffard, Rick Fader, John Hatch, Serge LaChapelle, and Andriatsimiova Razafindraibe. The 1995 ornithological survey of the RNI d'Andohahela was part of a biological inventory organized by WWF, Madagascar. We are grateful to WWF personnel in Tolagnaro and Antananarivo, including Lala Andriamanarivo, Mark Fenn, Olivier Langrand, and Sheila O'Connor. Joanna Durbin, Brian Fisher, Stig Jensen, Olivier Langrand, and Sheila O'Connor provided unpublished information on the birds of the region. Olivier Langrand graciously translated the abstract into French.

We are grateful to the curators of the following museums for loaning or allowing us access to material under their care: George Barrowclough, Stuart Keith, and Mary LeCroy, American Museum of Natural History, New York; Peter Colston, The Natural History Museum, formerly the British Museum (Natural History), Tring, England; D. Stefan Peters, Forschungsinstitut und Naturmuseum Senckenberg, Frankfort; Jean-François Voisin, Muséum National d'Histoire Naturelle, Paris; Leon Bennun, National Museum of Kenya, Nairobi; Storrs Olson, National Museum of Natural History, Washington, D.C.; and Voara Randrianasolo and Albert Randrianjafy, Parc Botanique et Zoologique de Tsimbazaza, Antananarivo, Madagascar.

For the identifications of plants we are grateful to George Schatz and Gordon MacPherson, Missouri Botanical Garden, and Armand Rakotozafy, Parc Botanique et Zoologique de Tsimbazaza; for insects to Tom Moore, University of Michigan Museum of Zoology, and Phil Parrillo, Field Museum of Natural History; and for reptiles and amphibians to Chris Raxworthy, University of Mich-

igan Museum of Zoology. Publication of this work was aided by a generous subsidy from QIT Madagascar Minerals Ltd. For comments on a earlier draft of the manuscript we are grateful to Olivier Langrand and Mike Putnam.

Literature Cited

ANDERSSON, M. 1995. Evolution of reversed sex roles, sexual size dimorphism, and mating system in coucals (Centropodidae, Aves). *Biological Journal of the Linnean Society*, **54**: 173–181.

ANDRIANARIMISA, A. 1994. Note on *Tylas eduardi* (*Tylas Vanga*) at Parc National Montagne d'Ambre. *Newsletter Working Group on Birds in the Madagascar Region*, **4**: 6.

ANDRIANBOLOLONA, A. 1979. L'approvisionnement en énergie de la région de Tuléar. *Mémoire Maîtrise, Université de Tuléar, Toliara, Madagascar*.

APPERT, O. 1966. Beitrag zur Biologie und zur Kenntnis der Verbreitung des Madagaskar Mahnenibisses *Loophotibis cristata* (Boddaert). *Journal für Ornithologie*, **107**: 315–322.

—. 1985. Zur biologie der Mesitornithiformes (Nakas oder "Stelzenrallen") Madagaskars und erste fotografische dokumente von vertretern der ordnung. *Ornithologische Beobachter*, **82**: 31–54.

BATTISTINI, R. 1964. Etude géomorphologique de l'extrême sud de Madagascar. *Editions Cujas, Toulouse*, 340 pp.

—. 1972. Madagascar relief and main types of landscape, pp. 1–25. *In* Battistini, R., and G. Richard-Vindard, eds., *Biogeography and Ecology in Madagascar*. W. Junk, The Hague, 765 pp.

BAZOT, G. 1974. Géologie de la région Fort Dauphin—Sainte Luce (Sud-Est de Madagascar). Direction des Mines et de l'Energie, *Travaux du Bureau Géologique*, Numéro 142, Antananarivo, Madagascar.

BEEHLER, B. 1982. Ecological structuring of forest bird communities in New Guinea, pp. 837–861. *In* Gressitt, J. L., ed., *Biogeography and Ecology of New Guinea*. W. Junk, The Hague.

BENSON, C. W., J. F. R. COLEBROOK-ROBJENT, AND A. WILLIAMS. 1977. Contribution à l'ornithologie de Madagascar. *L'oiseau et la Revue Française d'ornithologie*, **47**: 41–64, 167–191.

BERLIOZ, J. 1946. Oiseaux de la Réunion. *Imprimerie Arts Graphiques Modernes, Saint-Denis, Réunion*.

BESAIRIE, H. 1970. Carte Géologique de Madagascar, 1/500,000. Feuille Ampanihy No. 8. Service Géologique et Centre de l'Institut Géographique National à Madagascar, Tananarive.

BIERREGAARD, R. O., JR. 1990. Species composition and trophic organization of the understory bird community in a central American terra firme forest, pp. 217–236. *In* Gentry, A. H., ed., *Four Neotropical Forests*. Yale University Press, New Haven, Conn.

BLUNTSCHLI, H. 1932. In den Urwäldern auf Madagaskar. VI. In südlichen Bergwald und nach dem Trockenland Androy. *Umschau*, **36**: 1015–1019.

—. 1933. In den Urwäldern auf Madagaskar. *Die Umschau*, **37**: 30–33.

—. [1951]. Katalog der Sammlung von injizierten Kadavern Skeletten, Hauten und Balgen etc. Manuscript in American Museum of Natural History, New York.

BOURGEAT, F. 1972. Sols sur socle ancien à Madagascar. *Mémoires ORSTOM* no. 57, Paris.

BRENON, P. 1972. The geology of Madagascar, pp. 27–86. *In* Battistini, R., and G. Richard-Vindard, eds. *Biogeography and Ecology in Madagascar*. W. Junk, The Hague.

BRISSON, M. 1760. *Ornithologie ou méthode contenant la division des oiseaux*. Chez C. J.-B. Bauche, Paris.

BROWN, L. H., E. K. URBAN, AND K. NEWMAN. 1982. *The Birds of Africa*, vol. 1. Academic Press, London, xiii + 521 pp.

CHAPERON, P., J. DANLOUX, AND L. FERRY. 1993. *Fleuves et rivières de Madagascar*. Monographie Hydrologique 10, ORSTOM, Paris.

CHARLES, C. S. 1985. Les Mahafale de l'Onilahy: Des clans au royaume du XV^e siècle à la conquête coloniale. *Thèse Panthéon-Sorbonne, Paris*.

CHARLES-DOMINIQUE, P. 1976. Les gommes dans le régime alimentaire de *Coua cristata* à Madagascar. *L'oiseau et la Revue Française d'ornithologie*, **46**: 174–178.

COLLAR, N. J., AND S. N. STUART. 1985. *Threatened Birds of Africa and Related Islands*. International Council for Bird Preservation, Cambridge.

CRAWFORD, R. M. M. 1989. *Studies in plant survival—Ecological case histories of plant adaptations to adversity*. Blackwell Scientific Publications, Oxford.

DAUBETON (LE JEUNE), E. L. 1770–1786. [Planches enluminées d'histoire naturelle.] *In* Buffon, G. L. L., *Histoire naturelle de oiseaux. L'Imprimerie Royale, Paris*.

DECARY, R. 1926. Le Sud-Est de Madagascar. *Bulletin Economique de Madagascar*, **23**: 5–27.

—. 1927. Contribution à la botanique et à la géologie de la région Fort-Dauphin—Andrahomana. *Bulletin de l'Académie Malgache, (nouvelle série)* **10**: 13–18.

DEE, T. J. 1986. *The Endemic Birds of Madagascar*. International Council for Bird Preservation, Cambridge.

DELACOUR, J. 1931. Description de neuf oiseaux nouveaux de Madagascar. *L'oiseau et la Revue Française d'ornithologie*, **1**: 473–486.

—. 1932. Les oiseaux de la mission zoologique Franco-Anglo-Américaine à Madagascar, *L'oiseau et la Revue Française d'ornithologie*, **2**: 1–96.

DONQUE, G. 1972. The climatology of Madagascar, pp. 87–144. *In* Battistini, R., and G. Richard-Vindard, eds., *Biogeography and Ecology in Madagascar*. W. Junk, The Hague, 765 pp.

—. 1975. Contribution géographique à l'étude du climat de Madagascar. *Nouvelle Imprimerie des Arts Graphiques, Antananarivo, Madagascar*.

DRANSFIELD, J., AND H. BEENTJE. 1995. *The Palms of Madagascar*. Royal Botanic Gardens and International Palm Society, Kew, United Kingdom.

DU PUY, B., J. P. ABRAHAM, AND A. J. COOKE. 1994. Les plantes, pp. 15–29. In Goodman, S. M., and O. Langrand, eds., Inventaire biologique, Forêt de Zombitse. Recherches pour le Développement, série Sciences biologiques, no. spécial, Centre d'Information et de Documentation Scientifique et Technique, Antananarivo, Madagascar.

EBORKE, S. 1994. Approche phytosociologique de la parcelle 3 de la RNI d'Andohahela. Travaux de Recherches, Laboratoire de Phytobiologie, Université de Tuléar, Toliara, Madagascar.

EGUCHI, K., S. YAMAGISHI, H. NAGATA, M. NAKAMURA, AND V. RANDRIANASOLO. 1992. The mixed-species flocks of forest-living birds in Madagascar, pp. 28–38. In Yamagishi, S., ed., Social Structure of Madagascar Higher Vertebrates in Relation to Their Adaptive Radiation. Osaka City University, Osaka, Japan.

FARKAS, T. 1974. On the biology of *Monticola imerinus* (Hartlaub). Bulletin British Ornithologists' Club, **94**: 165–170.

FLACOURT, E. DE. 1658 [reprinted in 1995]. Histoire de la Grande Isle de Madagascar. Edition annotée et présentée par Claude Allibert. INALCO-Karthala, Paris.

FOSTER, M. S. 1975. The overlap of molting and breeding in some tropical birds. Condor, **77**: 304–314.

GLANDER, K. E., B. Z. FREED, AND J. U. GANZHORN. 1985. Meat eating and predation in captive-born semi-free-ranging *Lemur fulvus* and caged *Lemur macaco*. Zoo Biology, **4**: 361–365.

GIBBS, H. L., P. R. GRANT, AND J. WEILAND. 1984. Breeding of Darwin's Finches at an unusually early age in an El Niño year. Auk, **101**: 872–874.

GODFREY, L. R., W. L. JUNGERS, K. E. REED, E. L. SIMONS, AND P. S. CHATRATH. 1997. Subfossil lemurs: Inferences about past and present primate communities in Madagascar, pp. 218–256. In Goodman, S. M., and B. D. Patterson, eds., Natural Change and Human Impact in Madagascar. Smithsonian Institution Press, Washington, D.C.

GOODMAN, S. M., G. K. CREIGHTON, AND C. RAXWORTHY. 1991. The food habits of the Madagascar Long-eared Owl *Asio madagascariensis* in southeastern Madagascar. Bonner zoologische Beiträge, **42**: 21–26.

GOODMAN, S. M., AND O. LANGRAND. 1993. Food habits of the Barn Owl (*Tyto alba*) and the Madagascar Long-eared Owl (*Asio madagascariensis*) on Madagascar: Adaptation to a changing environment. Proceedings of the Pan-African Ornithological Congress, **8**: 147–153.

GOODMAN, S. M., O. LANGRAND, AND C. J. RAXWORTHY. 1993. The food habits of the Madagascar Long-eared Owl (*Asio madagascariensis*) in two habitats in southern Madagascar. Ostrich, **64**: 79–85.

GOODMAN, S. M., O. LANGRAND, AND J.-C. RAZAFIMA-HAIMODISON. 1994a. Les oiseaux, pp. 73–84. In Goodman, S. M., and O. Langrand, eds., Inventaire biologique, Forêt de Zombitse. Recherches pour le Développement, série Sciences biologiques, no. spécial, Centre d'Information et de Documentation Scientifique et Technique, Antananarivo, Madagascar.

GOODMAN, S. M., O. LANGRAND, AND B. M. WHITNEY. 1996. A new genus and species of passerine from the eastern rain forest of Madagascar. Ibis, **138**: 153–159.

GOODMAN, S. M., S. O'CONNOR, AND O. LANGRAND. 1994b. A review of predation on lemurs: Implications for the evolution of social behavior in small, nocturnal primates, pp. 51–66. In Kappeler, P. M., and J. Ganzhorn, eds., Lemur Social Systems and Their Ecological Basis. Plenum, New York.

GOODMAN, S. M., AND P. PARRILLO. In press. A study of the diets of insectivorous Malagasy birds based on stomach contents. Ostrich.

GOODMAN, S. M., AND M. PIDGEON. 1991. Madagascar Harrier Hawk *Polyboroides radiatus* preying on flying fox *Pteropus rufus*. Ostrich, **62**: 215–216.

GOODMAN, S. M., AND M. S. PUTNAM. 1996. The birds of the eastern slopes of the Réserve Naturelle Intégrale d'Andringitra, Madagascar, pp. 171–190. In Goodman, S. M., ed., A Floral and Faunal Inventory of the Eastern Slopes of the Réserve Naturelle Intégrale d'Andringitra, Madagascar: With Reference to Elevational Variation. Fieldiana: Zoology, new series, **85**: 158–170.

GOODMAN, S. M., AND D. RAKOTONDRAVONY. 1996. The Holocene distribution of *Hypogeomys* (Rodentia: Muridae: Nesomyinae) on Madagascar, pp. 283–293. In Lourenço, W. R., ed., Biogéographie de Madagascar. ORSTOM Editions, Paris.

GOODMAN, S. M., AND T. S. SCHULENBERG. 1991. The rediscovery of the Red-tailed Newtonia *Newtonia fannovanae* in south-eastern Madagascar with notes on the natural history of the genus *Newtonia*. Bird Conservation International, **1**: 33–45.

GOODMAN, S. M., D. E. WILLARD, AND P. C. GONZALES. 1995. The birds of Sibuyan Island, Romblon Province, Philippines, with Particular Reference to Elevational Distribution and Biogeographic Affinities. Fieldiana: Zoology, new series, **82**: 1–57.

GRANDIDIER, G. 1902. Observations sur les lémuriens disparus de Madagascar. Collections Alluaud, Gaubert, Grandidier. Bulletin Muséum d'Histoire Naturelle, Paris, **7**: 497–505, 587–592.

—. 1903. Description de l'*Hypogeomys australis*, une nouvelle espèce de rongeur sub-fossile de Madagascar. Bulletin Muséum d'Histoire Naturelle, Paris, **9**: 13–15.

—. 1928. Description de deux nouveaux mammifères insectivores de Madagascar. Bulletin Muséum National d'Histoire Naturelle, Paris, sér. 2, **34**: 63–70.

GREEN, G. M., AND R. W. SUSSMAN. 1990. Deforestation history of the eastern rainforests of Madagascar from satellite images. Science, **248**: 212–215.

GRIVEAUD, P. 1960. Une mission de recherche de l'I.R.S.M. au lac Ihotry (S.E. Morombe, Province de Tulear). Le Naturaliste Malgache, **12**: 33–41.

GYLDENSTOLPE, N. 1933. A remarkable new flycatcher from Madagascar. Arkiv för Zoologi, **25B**(2): 1–3.

HALLEUX, D., AND S. M. GOODMAN. 1994. The rediscovery of the Madagascar Red Owl *Tyto soumagnei* (Grandidier 1878) in north-eastern Madagascar. Bird Conservation International, **4**: 305–311.

HAWKINS, A. F. A., J.-M. THIOLLAY, AND S. M. GOODMAN. In press. The birds of the Réserve Spéciale d'Anjanaharibe-Sud, Madagascar. In Goodman, S. M., ed., A Floral and Faunal Inventory of the Réserve

Spéciale d'Anjanaharibe-Sud, Madagascar: With Reference to Elevational Variation. *Fieldiana: Zoology*.

HOOGSTRAAL, H. 1953. Ticks (Ixodoidea) of the Malagasy faunal region (excepting the Seychelles). Their origin and host relationships; with descriptions of five new *Haemaphysalis* species. *Bulletin Museum of Comparative Zoology*, **111**(2): 37–113.

HUMBERT, H. 1935. L'extinction des derniers vestiges de certains types de végétation autochone à Madagascar. *Archives Muséum National d'Histoire Naturelle*, Paris, sér. 6, **12**: 569–587.

—. 1941. Le massif de l'Andohahela et ses dépendances (Madagascar, Réserve Naturelle n° XI). Compte rendu sommaire des séances, Société de Biogéographie, **18**: 31–37.

JANZEN, D. H., M. ATAROFF, M. FARINAS, S. REYES, A. RINCON, A. SOLER, P. SORIANO, AND M. VERA. 1976. Changes in the arthropod community along an elevational transect in the Venezuelan Andes. *Biotropica*, **8**: 193–203.

JENKINS, M. D., ED. 1987. Madagascar: An Environmental Profile. International Union for the Conservation of Nature and Natural Resources, Conservation Monitoring Unit, Cambridge and Gland, 374 pp.

JOUANIN, C., AND J.-L. MOUGIN. 1979. Order Procellariiformes, pp. 48–118. In Mayr, E., and G. W. Cottrell, eds., *Check-list of Birds of the World*, 2nd ed., vol. 1. Museum of Comparative Zoology, Cambridge, Mass.

KAHL, M. P. 1979. Family Scopidae, pp. 244–245. In Mayr, E., and G. W. Cottrell, eds., *Check-list of Birds of the World*, 2nd ed., vol. 1. Museum of Comparative Zoology, Cambridge, Mass.

LANGRAND, O. 1990. Guide to the birds of Madagascar. Yale University Press, New Haven, Conn., xi + 364 pp.

—. 1995. Check List of the Birds of Amber Mountain National Park, Madagascar. WWF, Antananarivo, Madagascar.

LANGRAND, O., AND O. APPERT. 1995. Harlequin Quail *Coturnix delegorguei* and Common Quail *Coturnix coturnis* on Madagascar: Occasional migrants or resident species? *Ostrich*, **66**: 150–154.

LANGRAND, O., AND B.-U. MEYBURG. 1984. Birds of prey and owls in Madagascar: Their distribution, status and conservation. Proceedings of the Second Symposium on African Predatory Birds, Natal Bird Club, **1984**: 3–13.

LANGRAND, O., AND J. C. SINCLAIR. 1994. Additions and supplements to the Madagascar avifauna. *Ostrich*, **65**: 302–310.

LANGRAND, O., AND L. WILMÉ. 1997. Effects of forest fragmentation on extinction patterns of the endemic avifauna of the Central High Plateau of Madagascar, pp. 280–305. In Goodman, S. M., and B. D. Patterson, eds., *Natural Change and Human Impact in Madagascar*. Smithsonian Institution Press, Washington, D.C.

LAVAUDEN, L. 1937. Supplément. In Milne Edwards, A., and A. Granddier, eds., *Histoire physique, naturelle et politique de Madagascar*. Vol. 12, Oiseaux. Société d'Editions Géographiques Maritimes et Coloniales, Paris.

LOWRY, P. P., II, AND D. FABER-LANGENDOEN. 1991. Madagascar Minerals Project, Contract no. MMC-0093 and MMC-0109. Environmental Impact Assessment Study. Part I: Natural Environment. Appendix III: Flora and Vegetation Study. [Copy available in Field Museum of Natural History Library.]

MABBERLEY, D. J. 1989. *The Plant-book*. Cambridge University Press, Cambridge.

MACPHEE, R. D. E. 1987. The shrew tenrecs of Madagascar: Systematic revision and Holocene distribution of *Microgale* (Tenrecidae, Insectivora). *American Museum of Natural History Novitates*, **2889**: 1–45.

MACPHEE, R. D. E., AND D. A. BURNET. 1991. Dating of modified femora of extinct dwarf *Hippopotamus* from southern Madagascar: Implications for constraining human colonization and vertebrate extinction events. *Journal of Archaeological Science*, **18**: 695–706.

MARSHALL, J. T. 1978. Systematics of smaller Asian night birds based on voice. *Ornithological Monograph*, no. 25.

MAYR, E. 1942. *Systematics and the Origin of Species*. Columbia University Press, New York.

—. 1992. A local flora and the biological species concept. *American Journal of Botany*, **79**: 222–238.

MCCOY, E. D. 1990. The distribution of insects along elevational gradients. *Oikos*, **58**: 313–322.

MCKITTRICK, M. C., AND R. M. ZINK. 1988. Species concepts in ornithology. *Condor*, **90**: 1–14.

MILNE EDWARDS, A., AND A. GRANDDIER. 1879. *Histoire physique, naturelle et politique de Madagascar*. Volume XIV. *Histoire naturelle des oiseaux*. Tome I, texte, Paris.

MILON, P. 1950. Description d'une sous-espèce nouvelle d'oiseau de Madagascar. *Bulletin Muséum National d'Histoire Naturelle* (2e série), **22**: 65–66.

—. 1952. Notes sur le genre *Coua*. *L'oiseau et la Revue Française d'ornithologie*, **22**: 75–90.

MILON, P., J.-J. PETTER, AND G. RANDRIANASOLO. 1973. *Faune de Madagascar*. Tome XXXV, Oiseaux. ORSTOM/CNRS, Antananarivo and Paris.

MISSOURI BOTANICAL GARDEN. 1993. Botanical checklist of Réserve Naturelle Intégrale 11 (Andohahela). July 1993. Missouri Botanical Garden, St. Louis, Mo.

MORAT, P. 1973. Les savanes du sud-ouest de Madagascar. *Mémoires ORSTOM* no. 68, Paris.

MOREAU, R. E. 1936. Breeding seasons of birds in East African evergreen forest. *Proceedings of the Zoological Society of London*, **1936**: 631–653.

NAGATA, H., E. URANO, K. EGUCHI, AND S. YAMAGISHI. 1992. Avifauna of each study sites visited in Madagascar, pp. 21–27. In Yamagishi, S., ed., *Social Structure of Madagascar Higher Vertebrates in Relation to Their Adaptive Radiation*. Osaka City University, Osaka, Japan.

NICOLL, M., AND LANGRAND, O. 1989. Madagascar: *Revue de la conservation et des aires protégées*. World Wide Fund for Nature, Gland, Switzerland.

NOZET, G. 1953. *Carte géologique au 1/100.000 Tranomaro Marohotro*, Service Géologique, Antananarivo, Madagascar.

O'CONNOR, S. M. 1987. The effect of human impact on vegetation and the consequences to primates in two

riverine forests, southern Madagascar. Ph.D. thesis, Cambridge University, Cambridge.

O'CONNOR, S., M. PIDGEON, AND Z. RANDRIA. 1985. Un programme de conservation pour la Réserve d'Andohahela, pp. 31–36. In Mittermeier, R. A., L. A. Rakotovao, V. Randrianasolo, E. J. Sterling, and D. Devitre, eds. Priorités en matière de conservation des espèces à Madagascar. Occasional Papers of the IUCN Species Survival Commission, Gland, Switzerland.

OFFICE NATIONAL DE L'ENVIRONNEMENT. 1994. Rapport sur l'état de l'environnement à Madagascar. Programme des Nations Unies pour le Développement Banque Mondiale, Antananarivo, 208 pp.

OLSON, D. M. 1994. The distribution of leaf litter invertebrates along a Neotropical altitudinal gradient. *Journal of Tropical Ecology*, **10**: 129–150.

PAULIAN, R., C. BLANC, J.-L. GUILLAUMET, J.-M. BETSCH, P. GRIEVAUD, AND A. PEYRIÉAS. 1973. Étude des écosystèmes montagnards dans la région malgache. II. Les chaînes Anosyennes. Géomorphologie, climatologie et groupements végétaux. (Campagne RCP 225, 1971–1972). *Bulletin Muséum National d'Histoire Naturelle, Écologie générale*, third series, **118**: 1–40.

PERRIER DE LA BÂTHIE, H. 1936. Biogéographie des Plantes de Madagascar. Société d'Édition Géographiques, Maritimes et Coloniales, Paris.

PETERS, D. S. 1996. *Hypositta perdita* n. sp., eine neue Vogelart aus Madagaskar. *Senckenbergiana Biologica*, **76**: 7–14.

PEYROT, B. 1980. La vie rurale en pays Antanosy. Madagascar, *Revue de Géographie*, **37**: 111–138.

POULSEN, B. O. 1994. Mist-netting as a census method for determining species richness and abundances in an Andean cloud forest bird community. *Gerfaut*, **84**: 39–49.

PRIGOGINE, A. 1980. The altitudinal distribution of the avifauna in the Itombwe Forest (Zaire). *Proceedings of the Pan-African Ornithological Congress*, **4**: 169–184.

PUTNAM, M. S. 1996. Aspects of the breeding biology of Pollen's Vanga (*Xenopirostris polleni*) in south-eastern Madagascar. *Auk*, **113**: 233–236.

RAKOTOARISOA, J. A. 1994. Le peuplement de l'Anosy, les rapports de l'homme et son environnement, dans l'extrême sud-est de Madagascar. Thèse soutenue à l'INALCO, Paris.

—. 1997. A cultural history of Madagascar: Evolution and interpretation of the archaeological evidence, pp. 331–341. In Goodman, S. M., and B. D. Patterson, eds., *Natural Change and Human Impact in Madagascar*. Smithsonian Institution Press, Washington, D.C.

RAKOTONDRANONY, L. G. 1977. A propos de Berenty inventaire de l'avifaune notice sur les vertébrés non primates. Mémoire de fin d'études, Université de Madagascar, Etablissement d'Enseignement Supérieur des Sciences Agronomiques, Département Eaux et Forêts. [Copy available in the Field Museum of Natural History Library.]

RAND, A. L. 1933. Testicular asymmetry in the Madagascar Coucal. *Auk*, **50**: 219–220.

—. 1936. The distribution and habits of Madagascar birds. A summary of the field notes of the Mission Zoologique Franco-Anglo-Américaine à Madagascar. *Bulletin American Museum of Natural History*, **72**: 143–499.

—. 1951. The nests and eggs of *Mesoenas unicolor* of Madagascar. *Auk*, **68**: 23–26.

—. 1960. Family Vangidae, pp. 365–369. In Mayr, E., and J. C. Greenway, Jr., eds., *Check-list of Birds of the World*, vol. 9. Museum of Comparative Zoology, Cambridge, Mass.

RATSIRARSON, J. 1996. Importance de la recherche au sein du projet Beza Mahafaly. *Akon'ny Ala*, **18**: 12–25.

RATSIRARSON, J., J. A. SILANDER, JR., AND A. F. RICHARD. 1996. Conservation and management of a threatened Madagascar palm species, *Neodypsis decaryi*, Jumelle. *Conservation Biology*, **10**: 40–52.

RATSIVALAKA-RANDRIAMANGA, S. 1985. Recherches sur le climat de Tolagnaro (ex Fort-Dauphin) (Extrême Sud de Madagascar). Madagascar, *Revue de Géographie*, **46**: 47–67.

—. 1987. Climat et végétation de la région de Fort-Dauphin. Recherches pour le Développement, série Sciences de l'Homme et de la Société, 3 (premier semestre): 51–64.

RAZANABAHINY, V. 1995. Le Dina (Convention entre Membres de Communautés Villageoises) son opportunité ou non dans la conservation de la nature. Cas de la Réserve Naturelle Intégrale d'Andohahela—Tolagnaro. Mémoire C.A.P.E.N., École Normale Supérieure, Université d'Antananarivo, Antananarivo, Madagascar.

REMSEN, J. V., JR. 1994. Use and misuse of bird lists in community ecology and conservation. *Auk*, **111**: 225–227.

REMSEN, J. V., JR., AND D. A. GOOD. 1996. Misuse of data from mist-net captures to assess relative abundance in bird populations. *Auk*, **113**: 381–398.

REMSEN, J. V., JR., AND T. A. PARKER III. 1983. Contribution of river-created habitats to bird species richness in Amazonia. *Biotropica*, **15**: 223–231.

RICHARD, A. F., AND R. E. DEWAR. 1991. Lemur ecology. *Annual Review of Ecology and Systematics*, **22**: 145–175.

ROCHE, H. DE LA, AND J. MARCHAL. 1955–1956. Carte géologique au 1/200.000 Manantenina Fort-Dauphin, Service Géologique, Antananarivo, Madagascar.

SAFFORD, R. J., AND J. W. DUCKWORTH, EDs. 1990. A Wildlife Survey of Marojejy Nature Reserve, Madagascar. ICBP Study Report No. 40. International Council for Bird Preservation, Cambridge.

SALOMON, J.-N. 1993. La déforestation à Madagascar une dynamique inquiétante. Publication présentée à l'Université d'Hiver—Aupelf-Uref, mai 1993. Université d'Antananarivo. Problème de l'environnement en milieu tropical dans les îles de l'ouest de l'Océan Indien.

SALOMONSEN, F. 1933a. Les gobe-mouches de paradis de la région malgache. *L'oiseau et la Revue Française d'Ornithologie*, **3**: 603–614.

—. 1933b. Remarks upon the Madagascar Paradise Flycatchers. *Bulletin of the British Ornithologists' Club*, **53**: 119–124.

—. 1934. Revision of the Madagascar Timaliine birds. *Annals and Magazine of Natural History*, series 10, **14**: 60–79.

SALVAN, J. 1970. Remarques sur l'évolution de l'avifaune malgache depuis 1945. *Alauda*, **38**: 191–203.

SAUTHER, M. L. 1989. Antipredator behavior in troops of free-ranging *Lemur catta* at Beza Mahafaly Special Reserve, Madagascar. *International Journal of Primatology*, **10**: 595–606.

SCHULENBERG, T. S., S. M. GOODMAN, AND J.-C. RAZAFIMAHAIMODISON. 1993. Genetic variation in two subspecies of *Nesillas typica* (Sylviinae) in south-east Madagascar. *Proceedings of the Pan-African Ornithological Congress*, **8**: 173–177.

SHIRIHAI, H., I. SINCLAIR, AND P. R. COLSTON. 1995. A new species of *Puffinus* shearwater from the western Indian Ocean. *Bulletin of the British Ornithologists' Club*, **115**: 75–87.

SNOW, D. W., ED. 1978. An Atlas of Speciation in African Non-passerine birds. British Museum (Natural History), London, vii + 390 pp.

SNOW, D. W., AND B. K. SNOW. 1964. Breeding seasons and annual cycles of Trinidad land-birds. *Zoologica*, **49**: 1–39.

STORER, R. W. 1966. Sexual dimorphism and food habits in three North American accipiters. *Auk*, **83**: 423–436.

STRESEMANN, E. 1952. On the birds collected by Pierre Poivre in Canton, Manila, India and Madagascar (1751–1756). *Ibis*, **94**: 499–523.

TERBORGH, J. 1971. Distribution and environmental gradients: Theory and a preliminary interpretation of distributional patterns in the avifauna of the Cordillera Vilcabamba, Peru. *Ecology*, **52**: 23–40.

—. 1977. Bird species diversity on an Andean elevational gradient. *Ecology*, **58**: 1007–1019.

THORSTROM, R., AND R. WATSON. 1994. Avian Inventory of Masoala Peninsula, Madagascar. The Peregrine Fund, Boise, Id.

UILENBERG, G., H. HOOGSTRAAL, AND J. M. KLEIN. 1979. Les tiques (Ixodoidea) de Madagascar et leur rôle vecteur. Institut Pasteur de Madagascar, Numéro Spécial.

VERNON, C. J. 1971. Notes on the biology of the Black Coucal. *Ostrich*, **42**: 242–258.

WALKER, A. 1967. Locomotor adaptations in recent and subfossil Madagascan lemurs. Ph.D. thesis, University of London, London.

WATSON, R. T., AND S. STRZALKOWSKA. 1992. Project Masoala: Les trois prochaines années, pp. 87–106. In Watson, R. T., ed., *Le projet de conservation de l'aigle pêcheur de Madagascar et des zones humides et le projet Masoala: Utilisation des rapaces et d'autres faunes pour la gestion et l'évaluation de la conservation*. The Peregrine Fund, Boise, Id.

WHITE, F. 1983. *The Vegetation of Africa*. UNESCO, Paris.

WILKINSON, R. 1990. Notes on the breeding and behaviour of Greater Vasa Parrots *Coracopsis vasa* at Chester Zoo. *Avicultural Magazine*, **96**: 115–122.

WILKINSON, R., AND T. R. BIRKHEAD. 1995. Copulation behaviour in Vasa parrots *Coracopsis vasa* and *C. nigrina*. *Ibis*, **137**: 117–119.

WRIGHT, H. T., AND J. A. RAKOTOARISOA. 1997. Cultural transformations and their impact on the environments of Madagascar, pp. 309–330. In Goodman, S. M., and B. D. Patterson, eds., *Natural Change and Human Impact in Madagascar*. Smithsonian Institution Press, Washington, D.C.

WRIGHT, H. T., J. A. RAKOTOARISOA, G. HEURTEBIZE, AND P. VÉRIN. 1993. The evolution of settlement systems in the Efaho River Valley, Anosy: A preliminary report on archaeological reconnaissances of 1983–1986. *Indo-Pacific Prehistory Bulletin*, **12**: 2–20.

YAMAGISHI, S., AND K. EGUCHI. 1996. Comparative foraging ecology of Madagascar vangids (Vangidae). *Ibis*, **138**: 283–290.

YAMAGISHI, S., E. URANO, N. RAKOTOARISON, H. RANDRIAMAHAZO, AND V. RANDRIANASOLO. 1992. A possible significance of dichromatism in male Madagascar Paradise Flycatchers (*Terpsiphone mutata*), pp. 58–61. In Yamagishi, S., ed., *Social Structure of Madagascar Higher Vertebrates in Relation to Their Adaptive Radiation*. Osaka City University, Osaka, Japan.

APPENDIX 1. Gazetteer of localities mentioned in the text.

Locality	Eastern latitude		Southern longitude		Elevation (m)
	°	'	°	'	
Ambavarano, Lac	47	03	24	58	
Ambatoabo	46	40	24	51	
Ambatomaniha, Col d'	46	45	24	46	~1000
Amboasary-Sud	46	24	25	03	
Ambohitantely, RS	~47	16	~18	09	1450–1660
Ambolomitsaky River	47	19	24	48	
Ambovombe	46	05	25	11	
Ampamakiesiny, Col d'	46	50	24	31	1375
Ampanihy	44	45	24	42	
Amparihy-Est	47	21	23	57	30
Analalava Forest	47	19	24	13	20–50
Analamazaotra, RS	48	28	18	28	930–1040
Andohafasy, River	47	12	24	47	0–20
Andohahela, Pic	46	42	24	38	1935
Andonabe	46	49	24	41	~100
Andrahomana Cave	46	40	25	50	
Andranohela River	~46	47	~24	38	
Andraraky Hills	46	38	24	58	
Andratina River	46	07	24	34	
Andratoloharano, Lac	46	51	25	06	0–10
Andriambe, Lac	46	55	25	04	0–10
Anjanaharibe-Sud, RS	~49	26	~14	42	500–2064
Anjapolo	46	12	24	54	~50
Ankapaky	46	39	25	12	
Ankapoky Forest	46	31	24	59	
Ankarafantsika, RNI	~46	57	~16	09	80–330
Ankepotisy	46	43	24	32	1500
Anony, Lac	46	31	25	08	0–10
Antanandava Forest	46	48	24	34	
Antseva	46	48	24	31	850
Bealoka	46	16	24	57	
Beampingaratra	46	51	24	28	
Befotaka-Sud	46	59	23	50	740
Behara	46	23	24	57	40
Bemangidy	47	14	24	34	~100
Bemangily	(see Bemangidy)				
Berenty, RP	46	17	24	59	
Bevala	46	24	25	06	~40
Bevilany	46	36	25	01	~100
Bezavona	46	58	25	01	
Ebelo	46	02	24	29	
Efaho River	46	52	25	48	
Ejeda	44	31	24	20	
Eminiminy	46	49	24	41	~300
Enakara	46	54	24	37	
Enaniliha	46	53	24	39	
Enosiary	46	49	24	40	
Erombo, Lac	46	37	25	09	0–15
Esira	46	43	24	20	400
Esomony	46	38	24	30	530
Evasia	46	42	24	46	
Fampanambo	49	39	15	21	
Fampanombo	(see Fampanambo)				
Farafangana	47	50	22	49	
Fenoево	46	53	24	42	
Fort-Dauphin	(see Tolagnaro)				
Fotsivolo	46	35	24	58	
Hazofotsy	46	33	24	49	~100

APPENDIX 1. *Continued.*

Locality	Eastern latitude		Southern longitude		Elevation (m)
	°	'	°	'	
Ifotaka	46	08	24	48	
Ihotry, Lac	43	41	21	56	
Imonty	46	41	24	49	
Isaka-Ivondro	46	52	24	48	
Isedro, Col de	(see Ambatomanihia, Col d')				
Isedro Trail	46	46	24	46	
Itapera	47	07	24	53	0–20
Itrafanaomby	(see Trafonaomby)				
Kirindy Forest	44	43	20	03	
Lakandava Forest	46	58	25	01	
Lanirano, Lac	46	59	25	01	0–20
Lokaro	46	48	24	41	0–20
Mahamavo	46	43	24	46	370
Mahamavo, Col de	46	42	24	38	
Malaza Forest	46	17	24	59	
Manambaro	46	49	25	02	
Manampanihy River	~46	58	~27	35	
Manafiafy	47	11	24	45	0–20
Mananivo, Lac	47	07	24	56	
Manantantely Forest	46	55	24	59	50–600
Manantenina	47	19	24	17	30
Mandena	47	00	24	58	0–20
Mandrare River	46	24	25	03	
Mananara River	46	33	24	50	
Manangotry, Col de	46	52	24	45	~830
Mananivo, Lac	47	07	24	55	
Manombo, RS	47	44	23	02	0–137
Maroalina	46	51	24	35	
Maroantsetra	49	44	15	26	
Marojejy, RNI	~49	15	~14	26	75–2133
Marosalohy Forest	46	51	24	30	
Marosohy Forest	46	49	24	34	350–1300
Marosohy, Col de	46	48	24	32	~1300
Marovony Forest	47	20	24	05	50–100
Marotsiva	46	47	24	31	
Mokobe	46	38	24	58	
Morondava	44	17	20	17	
Nahampoana	46	58	24	58	75–300
Namoroka, RNI de	~45	20	~16	27	70–200
Petriky	46	53	25	04	0–40
Pic St. Louis	46	58	25	01	530
Pointe Evatra	47	06	24	59	0–20
Ranomafana, PN	47	28	21	16	
Ranomafana Atsimo	(see Ranomafana-Sud)				
Ranomafana-Sud	46	57	24	34	40
Ranomafana-Tanoso	(see Ranomafana-Sud)				
Ranomainty	46	32	25	00	
Ranopiso	46	42	25	04	
Ranopiso River	46	41	25	04	
Ranopiso, Col de	46	39	25	02	~300
Saihady	47	06	24	57	~10–40
Sedro	(see Isedro)				
Soavary	46	59	24	08	~30
Ste. Luce	(see Manafiafy)				
Tanatana, Col de	46	51	24	44	~750
Tapera	(see Itapera)				
Tarantsy River	46	34	25	00	~70
Toby	(see Bealoka)				

APPENDIX 1. *Continued.*

Locality	Eastern latitude		Southern longitude		Elevation (m)
	°	'	°	'	
Tolagnaro	46	59	25	01	0–40
Trafonaomby, Pic	46	44	24	33	1956
Tranomaro	46	39	24	36	
Tsiombe	45	29	25	18	
Tsitongambarika, Col de	47	00	24	42	~800
Tsitongatona River	46	49	24	35	
Tsivory	46	05	24	04	
Varavara Forest	46	43	24	30	
Varavara, Col	46	43	24	31	
Varinadambo	46	50	24	45	
Vohibaka	46	46	24	32	
Vohidagaro Hills	46	35	24	55	1005
Vohimainty Hills	46	35	24	55	965
Vohamena, Pic	46	58	24	43	1358
Vohidava Hills	46	18	24	18	
Vohimena, Pic	47	03	24	35	1173
Vohitsiombe	46	09	24	26	
Zahamena, RNI	~48	50	~17	40	750–1512

APPENDIX 2. Names of plant genera, species, and families mentioned in the text.¹

Genus/species	Family	Genus/species	Family
<i>Abrus</i>	Fabaceae	<i>Ficus grevei</i>	Moraceae
<i>Acacia farnessiana</i>	Fabaceae	<i>Ficus megapoda</i>	Moraceae
<i>Acacia minnuitiflora</i>	Fabaceae	<i>Flacourtie lucidiaeefolia</i>	Flacourtiaceae
<i>Acacia rovumae</i>	Fabaceae	<i>Gaertnera</i>	Rubiaceae
<i>Acacia sakalava</i>	Fabaceae	<i>Gyrocarpus americanus</i>	Hernandiaceae
<i>Adansonia za</i>	Bombacaceae	<i>Hibiscus</i>	Malvaceae
<i>Agave rigidula</i>	Agavaceae	<i>Hippocratea rubignosa</i>	Celastraceae
<i>Aguaria</i>	Ericaceae	<i>Humbertia madagascariensis</i>	Convolvulaceae
<i>Alberta</i>	Rubiaceae	<i>Ilex mitis</i>	Aquifoliaceae
<i>Albizia polyphylla</i>	Fabaceae	<i>Impatiens</i>	Balsaminaceae
<i>Alluaudia ascendens</i>	Didiereaceae	<i>Kalanchoe beharensis</i>	Crassulaceae
<i>Alluaudia comosa</i>	Didiereaceae	<i>Kalanchoe gastonis</i>	Crassulaceae
<i>Alluaudia humbertii</i>	Didiereaceae	<i>Macaranga</i>	Euphorbiaceae
<i>Alluaudia procera</i>	Didiereaceae	<i>Maeura filiformis</i>	Capparidaceae
<i>Aloe divaricata</i>	Liliaceae	<i>Malva</i>	Malvaceae
<i>Aloe vaombe</i>	Liliaceae	<i>Marattia fraxineae</i>	Marattiaceae
<i>Aloe vaotsanda</i>	Liliaceae	<i>Mascarenhasia</i>	Apocynaceae
<i>Antiroheia</i>	Rubiaceae	<i>Medinilla</i>	Melastomataceae
<i>Aphloia theiformes</i>	Flacourtiaceae	<i>Melia azedarach</i>	Meliaceae
<i>Asplenium</i>	Aspleniaceae	<i>Millettia</i>	Leguminosae
<i>Azima tetracantha</i>	Salvadoraceae	<i>Moringa</i>	Moringaceae
<i>Bauhinia</i>	Leguminosae	<i>Morus</i>	Moraceae
<i>Bulbophyllum</i>	Orchidaceae	<i>Nastus</i>	Poaceae
<i>Canarium obovatum</i>	Burseraceae	<i>Neotina isoneura</i>	Sapindaceae
<i>Capparis chrysomeia</i>	Capparaceae	<i>Nepenthes madagascariensis</i>	Nepenthaceae
<i>Capparis sepiaria</i>	Capparaceae	<i>Nymphaea</i>	Nymphaeaceae
<i>Cassia</i>	Fabaceae	<i>Ocotea</i>	Lauraceae
<i>Casuarina</i>	Casuarinaceae	<i>Oncostemon</i>	Myrsinaceae
<i>Celtis gomphophylla</i>	Ulmaceae	<i>Opuntia</i>	Cactaceae
<i>Celtis philippensis</i>	Ulmaceae	<i>Pachypodium</i>	Apocynaceae
<i>Cerbera venenifera</i>	Apocynaceae	<i>Pandanus</i> spp.	Pandanaceae
<i>Chrysophyllum boivinianum</i>	Sapotaceae	<i>Philippia</i>	Ericaceae
<i>Citrus</i>	Rutaceae	<i>Phragmites communis</i>	Poaceae
<i>Commelina ramulosa</i>	Commelinaceae	<i>Phyllanthus seyrigii</i>	Euphorbiaceae
<i>Commiphora</i>	Burseraceae	<i>Pithecellobium dulce</i>	Leguminosae
<i>Cordia ronnii</i>	Boraginaceae	<i>Pittosporum</i>	Pittosporaceae
<i>Cordia sinensis</i>	Boraginaceae	<i>Pothos scandens</i>	Araceae
<i>Crateva excelsa</i>	Capparidaceae	<i>Quivisanthe papiniae</i>	Meliaceae
<i>Crotalaria</i>	Leguminosae	<i>Ravenala madagascariensis</i>	Strelitziaeae
<i>Croton</i>	Euphorbiaceae	<i>Ravensara</i>	Lauraceae
<i>Croton monge</i>	Euphorbiaceae	<i>Rinoria greveana</i>	Vitaceae
<i>Cyathaea</i>	Cyathaceae	<i>Sarcolaena multiflora</i>	Sarcolaenaceae
<i>Cynanchum</i>	Asclepiadaceae	<i>Sarcostemma decorsei</i>	Asclepiadaceae
<i>Delonix regia</i>	Leguminosae	<i>Sloanea rhodantha</i>	Elaeocarpaceae
<i>Dicoma</i>	Asteraceae	<i>Sorindeia madagascariensis</i>	Anacardiaceae
<i>Dicoryphe viticoides</i>	Hamamelidaceae	<i>Strongylodon</i>	Fabaceae
<i>Didiera</i>	Didiereaceae	<i>Symphonia</i>	Clusiaceae
<i>Dilobea thouarsii</i>	Proteaceae	<i>Syzygium</i>	Myrtaceae
<i>Diospyros myriophylla</i>	Edenaceae	<i>Tabernaemontana</i>	Apocynaceae
<i>Dombeya</i>	Sterculiaceae	<i>Tamarindus indica</i>	Fabaceae
<i>Dracaena reflexa</i>	Dracaenaceae	<i>Tambourissa</i>	Monimiaceae
<i>Dypsis decaryi</i>	Arecaceae	<i>Tarenna purinosum</i>	Rubiaceae
<i>Elaeocarpus</i>	Elaeocarpaceae	<i>Tina isoneura</i>	Sapindaceae
<i>Erythrina</i>	Leguminosae	<i>Typhonodorum</i>	Araceae
<i>Erythroxylum gerrardi</i>	Erythroxylaceae	<i>Uapaca</i>	Euphorbiaceae
<i>Eucalyptus citriodora</i>	Myrtaceae	<i>Vaccinium</i>	Ericaceae
<i>Euphorbia leucodendrum</i>	Euphorbiaceae	<i>Vepris sclerophylla</i>	Rutaceae
<i>Euphorbia stenoclada</i>	Euphorbiaceae	<i>Weinmannia</i>	Cunoniaceae
<i>Euphorbia tirucalli</i>	Euphorbiaceae	<i>Xerophyta</i>	Velloziaceae
<i>Fernandoa madagascariensis</i>	Bignoniaceae		

¹ Family allocation generally after Mabberley (1989).



Index to Malagasy Vernacular Bird Names

akanga 34
akoala 27
akoholahin'ala 27
akohon'ala 27
aliotsy 47
andreabokia 71
angetry 75
angoiky 79
aoka 46
arakandroka 39
asity 60
bemaso 79
bevorotse 32
bifeko 84
bintitra 56
biriky 36
bita 79
bitraky 78
boeza 43
bohaky 42
bokazava 64
bokazavo 64
boky 29
boloky 44
borisy 62
bria 62
deho 42
eoka 46
fandikalala 49
fandraokibo 32
fantsasatry 58
farivaza 45
fatsatsatry 77
fifiokala 82
fihia 30
fileliakondro 30
fililiotra 54, 63
fitadroanga 68
fitatr'ala 67
fitatra 67
fitatry 24, 67
fodibeotse 89
fodimanta 90
fodisiay 88
fody ala 88
fody mena 89
foli manga 43
foly manga 43
folymena 89
fonomavo 42
fonomity 43
goaka 87
goaky 87
goapakala 54
haka 51
hankana 53
hatrakatra 41
hatrakatraka 41
heko heko 51
hindry 32
hitsikitsika 33
hitsikitsiky 33
hondria 32
hora 51
horova 66
horovana 66
joriroke 62
kariaka 45
kariaky 45
katia 79
keho 25
kia 43, 44
kibo 35
kiky 35
kimokimo 42
kirikirioky 57
kirio 57
kitreoky 45
koaky 87
kolokoloky 40
kopaky 54
kotohake 51
langopaka 54
langopaka tataro 54
lombokoma 25
lova 86
mandom bokomana 25
maritay 88
mavoloha 64
ongongo 28
papango 30
parataka 69
parataky 65
peeda 67
pokafy 47, 58
pretaka 65
pretaky 65
ragado 26
raillovy 86
ramaro 88
rangado 26
razamboay 24
rehiriky 33
rengetry 75
revitsy 56
revitsy'ala 56
rimaly 75
rimaro 88
sadakely 29
salaly kely 38
salaly be 38
sama 28
sarivazy 45
simitsy 69
siay 79
soy 61, 78
soy lehibe 79
soy manga 78
soy kely 78
taitoaky 47
takatry 26
takatsy 26
taleva 36
talevana 37
taotaokafo 45
tatarao-ala 54
tatarobobaky na lakopaky 58
teraratsy 57
teso 50
tetso 50
tetso manga 50
tivoka 50
toloho 51
toro 52
torotoroka 52
traotrao 34
treo-tre 59
triotrio 63
tsikaloto 42
tsikiniry 90
tsikiriokirioke 57
tsikodara 59
tsikoja 36
tsikonina 66
tsikorova 66
tsiksoysoy 78
tsilaka 67
tsilotsilon'aka 54, 63
tsilovanga 82
tsimala 30
tsimimitraka 73
tsimimitrala 74
tsimimitry 71
tsimimitsy 71
tsimitsy 73
tsimpirity 90
tsipara 32
tsipara korovana 32
tsipiritsy 90
tsiraraka 57
tsirikititio 64
tsiriry 28
vanga 82
vaza 44
vazambe 43
vazatsihotsy 44
vintsy 56
vorokotsy 25
vorompijkoka 84
vorompotsy 25
vorondolo 51, 52
vorondreo 59
voronzaza 83
zea-zea 73

Index to Scientific Names

Page numbers in **bold** indicate the main species account.

Abrus 42, 125
Acacia 13, 14, 31, 43, 44, 46, 79, 86
 farnessiana 44, 45, 77, 125
 minnitiflora 125
 rovumae 14, 24, 30, 31, 32, 33, 45, 48, 57, 73, 77, 79, 82, 125
 sakalava 77, 125
Accipiter 30
 francesii 86, 92, 96, 99, 100, 101, 104, 114
 francesii francesii **31–32**, 106
 henstii **31**, 92, 96, 106
 madagascariensis **31**, 32, 67, 92, 104, 106
Accipitridae 29
Acanthophis dumerili 46
Acridoheres tristis 31, **87–88**, 94, 97, 104, 105
Acrocephalus newtoni **68**, 93, 96
Actitis hypoleucos **39**, 92, 96
Actophilornis albinucha **37**
Adansonia 2, 13, 30, 83
 za 5, 88, 125
Agapornis cana 57, 93, 95, 99, 104, 111
 cana ablactanea **44–45**, 106
 cana cana **44–45**, 106
Agave rigidia 44, 45, 77, 79, 102, 125
Aguaria 11, 125
Alaudidae 62
Alberta 11, 125
Albizia 13, 86
 polyphylla 14, 30, 45, 48, 49, 77, 125
Alcedinidae 55
Alcedo vintsioides 93, 96, 99, 101, 102
 vintsioides vintsioides **55–56**
Alectroenas 43, 93
 madagascariensis 21, **42–43**, 96, 106
Alluaudia 13, 14, 32, 33, 44, 83, 84, 116
 ascendens 5, 15, 125
 conosa 5, 125
 humbertii 13, 125
 procera 5, 44, 45, 82, 84, 116, 125
Aloe 13, 77
 divaricata 77, 78, 79, 125
 vaombe 77, 78, 79, 125
 vaotsanda 5, 125
Anas bernieri 21
 erythroryncha **28–29**, 92, 96
 hottentotta **29**, 92
 melleri **28**, 91, 92
Anatidae 28
Antiroheia 9, 125
Anseriformes 28
Aphloia theiformes 9, 125
Apodidae 54
Apodiformes 54
Apus barbatus [*balstoni*] **54**, **55**, 63, 93, 97
 melba [*willsi*] **55**, 63, 93, 97
Ardea cinerea 92, 96
 cinernea firasa **26**
 humbloti **26**, 92
 purpurea 92, 96
 purpurea madagascariensis **25–26**
Ardeidae 24
Ardeola idae **24**, 92, 96
 ralloides **24**, 92, 96
Arenaria interpres **39**, 92
Asio capensis [*hova*] **53**, 93
 madagascariensis **52–53**, 91, 93, 95, 96, 106
Asplenium 9, 125
Atelornis crossleyi **58**, 93, 96, 107
 pittiooides **58**, 91, 93, 96, 102, 107
Avahi **53**
Aviceda madagascariensis **29**, 92, 96, 106
Azima tetracantha 75, 125
Bakerella 61, 78, 90
Bauhinia 14, 125
Boophis madagascariensis 53
Brachypteroicas leptosomus **57–58**, 91, 93, 97, 101, 106
 quamiger **57**, **58**, 91, 93, 97, 102, 107
Brachypteraciidae 57, 105
Bubulcus ibis **24–25**, 30, 92, 96
Bulbophyllum 9, 125
Bulweria fallax **23**
Buteo 87
 brachypterus 30, **32**, 92, 96, 104, 106
Butorides striatus 92, 96
 striatus rutenbergi **25**
Calicalicus madagascariensis 31, **80**, 94, 97, 101, 107
Calidris alba **39**, 92
 ferruginea **39–40**, 93
Calumma nasutus 50, 52, 56
Campephagidae 63
Canarium 11
 obovatum 9, 125
Canirallus kioloides 35, 92, 96
 kioloides kioloides **36**, 106
Capparis 66, 72
 chrysomeia 77, 79, 125
 seppiaria 75, 125
Caprimulgidae 53
Caprimulgiformes 53
Caprimulgus enarratus **54**, 91, 93, 95, 96, 101, 106, 114
 madagascariensis 93, 96, 99, 101
 madagascariensis madagascariensis **53–54**
Cassia 125
Casuarina 8, 87, 125
Catharacta antarctica **40**
Celtis gomphophyla 14, 43, 125
 philippensis 14, 43, 44, 49, 66, 82, 125
Centropus grillii 50
 toulou 53, 93, 96, 100, 104, 105
 toulou toulou **50–51**, 106
Charadriidae 37
Charadriiformes 37
Charadrius hiaticula [*tundrae*] **38**, 92
 leschenaultii **38**, 92
 marginatus tenellus **38**
 pecuarius 92
 pecuarius pecuarius **38**

thoracicus [bifrontatus] 38, 92, 95
tricollaris 38, 92
Chlidonias hybridus [sclateri] 40
Chrysophyllum boivinianum 9, 11, 125
Ciconiidae 26
Ciconiiformes 24
Circus maillardi 30
Cisticola cherina 70, 94, 97, 99, 104, 105
Citrus 77, 125
Collocalia francica 54
Columbidae 41
Columbiformes 41
Cominella ramulosa 12, 13, 125
Cominiphora 13, 125
Copsychus albospecularis 31, 93, 97, 99, 100, 101, 102, 104, 114
albospecularis albospecularis 107
albospecularis inexpectatus 67, 107
albospecularis pica 67, 107
Coraciidae 57
Coraciiformes 55
Coracina cinerea 79, 93, 97, 100
cinerea cinerea 63–64, 107
cinerea pallida 63–64, 107
Coracopsis 57
nigra 93, 96, 100, 104
nigra libis 43, 106
nigra nigra 43–44, 106
vasa 93, 96, 104
vasa drouhardi 43, 106
vasa vasa 43, 106
Cordia 77
ronnii 66, 79, 125
sinensis 125
Corvus albus 82, 86–87, 88, 94, 97, 104
Coturnix coturnix [africana] 34, 92
Coua 95
caerulea 48, 49–50, 93, 96, 100, 106
cristata 93, 96, 97, 104
cristata cristata 106
cristata maxima 47–49
cristata pyropyga 47–49, 106
cursor 47, 93, 96, 106
gigas 45–46, 75, 90, 91, 93, 95, 96, 100, 104, 106
reynaudi 46–47, 48, 93, 96, 106
ruficeps 93, 96
ruficeps olivaceiceps 47, 106
serriana 101, 106
verreauxi 49
Crateva excelsa 14, 45, 66, 79, 82, 83, 125
Crossleyia xanthophrys 76–77, 94, 97, 101, 102, 107, 111
Crotalaria 13, 125
Croton 12, 13, 44, 45, 125
monge 11, 125
Cryptosylvicola randrianasoloi 68–69, 81, 94, 95, 97, 107, 111
Cuculidae 45
Cuculiformes 45
Cuculus audeberti 106
cristata 48
rochii 45, 93, 96, 106
Cyanolanius madagascarinus 31, 79, 94, 97, 102
madagascarinus madagascarinus 84–85, 108
Cynanchum 13, 77, 125
Cypsiurus parvus 54–55, 63, 93, 97
Cythea 11, 125
Daption capense 23
Decaryia 13
Delonix 13
regia 77, 125
Dendrocygna bicolor 28, 92, 96
viduata 28, 92, 96
Dicoma 77, 125
Dicoryphe viticoides 11, 125
Dieruridae 86
Dicrurus forficatus 30, 79, 81, 87, 94, 97, 99, 100, 101, 102, 104, 105, 114
forficatus forficatus 86, 108
Didierea 125
Dilobeia thouarsii 9, 125
Diomedea cauta 22
chlororhynchos 23
Diomedeidae 22
Diospyros 65
myriophylla 13, 125
Dombeya 9, 11, 125
Dracaena reflexa 9, 125
Dromaeocercus brunneus 70, 94, 97, 107, 111
seeboldii 107
Dryolimnas cuvieri 92, 96, 100
cuvieri cuvieri 35–36, 106
Dypsis decaryi 12, 13, 55, 125
Egretta alba 92, 96
alba melanorhynchos 25
ardesiaca 25, 92, 96
dimorpha 25, 92, 96
Elaeocarpus 11, 125
Eliurus minor 53
webbi 53
Erythrina 125
Erythroxylum gerrardi 12, 125
Estrildidae 90
Eucalyptus 16, 31, 116, 125
citriodora 77
Eulemur fulvus 43, 50
Euphorbia 13, 14, 70, 71, 82
leucodendrum 125
stenoclada 5, 125
tirucalli 64, 77, 125
Euryceros prevostii 101, 108
Eurylamidae 59
Eurystomus 30, 53, 57, 86
glaucurus 44, 93, 97, 104
glaucurus glaucurus 57, 106
Eutriorchis astur 101, 106
Falco concolor 33, 57, 92, 96, 104, 105
eleonorae 33, 92, 96, 104
newtoni 30, 92, 96, 99, 104
newtoni newtoni 32–33, 106
peregrinus [radama] 33–34, 92, 104, 106
zoniventris 33, 92, 95, 96, 104, 106
Falconidae 32
Falconiformes 29
Falculea palliata 83, 84, 94, 97, 108
Fernandoa madagascariensis 64, 77, 78, 79, 125

Ficus 9, 14, 42, 43, 44
grevei 42, 82, 125
megapoda 43, 125
Flacourtia lucidiaefolia 13, 125
Foudia madagascariensis 33, 87, 89, 94, 97, 99, 101, 104, 105, 108
omissa 89–90, 94, 97, 101, 102, 108
Fulica cristata 37

Gaertnera 11, 61, 125
Galidia elegans 82
Galliformes 34
Gallinago macrodactyla 39, 92
Gallinula chloropus 36, 92, 96
Geogale aurita 51
Glareola ocularis 37, 92
Glareolidae 37
Gruiformes 34
Gyrocarpus americanus 88, 125

Hapalemur 53
Hartertula flavoviridis 74, 94, 97, 101, 102, 107, 111
Hartlaubius auratus 87, 94, 97, 108
Heterixalus boettgeri 50
Hibiscus 72, 77, 125
Hippocratea rubignosa 44, 125
Hipposideros commersoni 53
Hirundinidae 62
Hirundo rustica 63, 93
Humbertia madagascariensis 44, 125
Hypositta corallirostris 85, 94, 97, 107
perdita 85
Hypsipetes madagascariensis 31, 53, 79, 86, 93, 97, 99, 100, 101, 102, 104, 105, 114
madagascariensis madagascariensis 66–67, 107
Hypogeomys australis 111

Ilex mitis 9, 125
Impatiens 11, 125
Ispidina madagascariensis 93, 97, 99, 101, 102, 114
madagascariensis diluta 106
madagascariensis madagascariensis 56, 106
Ixbrychus minutus 24, 92

Jacanidae 37

Kalanchoe 13
beharensis 77, 78, 125
gastonis 125

Laridae 40
Larus dominicus 40, 93
Lemur catta 30, 32, 78
Leptopterus chabert 94, 97, 99, 104
chaberti chaberti 84, 108
chaberti schistocercus 84, 108
viridis 79, 81, 83, 94, 97, 102, 104
viridis annae 108
viridis viridis 83–84, 108

Leptosomatidae 58
Leptosomus discolor 58–59, 86, 93, 97
discolor discolor 107

Limosa lapponica 92
lapponica lapponica 38
Lonchura nana 87, 90, 94, 97, 104
Lophotibis cristata 91, 92, 95, 96, 100

cristata cristata 26–27, 106
cristata urschi 27, 106
Lygodactylus 31

Maba 12
Mabuya 31, 49
Macaranga 9, 11, 44, 79, 125
Machaeramphus alcinus [anderssoni] 29, 92, 106
Maeura filiformis 77, 125
Malva 77, 125
Mantidactylus lugubris 56
Marattia fraxineae 11, 125
Margaroperdix madagascarensis 34, 92, 96
Mascarenhasia 77, 125
Medinilla 61, 125
Melia azedarach 44, 66, 125
Meropidae 56
Merops superciliosus 93, 97, 100, 101, 104
superciliosus superciliosus 56–57
Mesitornis unicolor 34–35, 91, 92, 106
Mesitornithidae 34
Microcebus 53
murinus 51
rufus 81
Microgale decaryi 111
principula 111
Milletia 12, 125
Milvus migrans 92, 96, 104
migrans parasitus 29–30
Mirafrla hova 62, 93, 97, 104
Monarchidae 74
Moringa 13 125
Morus 42, 125
Motacilla flaviventris 63, 93, 97, 102
Motacillidae 63
Mus musculus 53
Mycteria ibis 26
Mystacornis crossleyi 77, 94, 97, 101, 102, 107, 114

Nastus 9, 125
Nectarinia 61, 105
notata 67, 77, 80, 94, 97, 99, 100, 101, 114
notata notata 78–79, 107
souimanga 61, 67, 71, 80, 81, 94, 97, 99, 100, 101, 102, 104, 105, 114
souimanga apolis 77–78, 107
souimanga souimanga 77–78, 107

Nectariniidae 77
Neodrepanis coruscans 60–61, 91, 93, 97, 101, 102, 107
hypoxantha 61–62, 78, 93, 97, 102, 107, 111
Neomixis 81
striatigula 72, 94, 97, 99, 104, 111
striatigula pallidior 73, 107
striatigula scalaris 73, 107
striatigula striatigula 73
tenella 45, 71, 72–73, 94, 97, 99, 100, 104, 105
tenella debilis 72, 107
tenella orientalis 72, 107
tenella tenella 72, 107
viridis 72, 73, 94, 97, 107
viridis viridis 73

Neotina 86
isoneura 14, 30, 32, 43, 44, 45, 57, 66, 84, 125
Nepenthes madagascariensis 14, 125
Nephila 66, 74, 81
Nesillas lanztii 69, 94, 97, 107, 109

typica 94, 97, 101, 102, 109, 114
typica typica 69, 107, 109
Newtonia 71, 81
amphichroa 70–71, 72, 94, 97, 101, 102, 107, 114
archboldi 71–72, 94, 95, 97, 99, 107
brunneicauda 32, 70, 72, 79, 81, 94, 97, 99, 100, 101, 102, 104, 114
brunneicauda brunneicauda 71, 107
fanovanae 72, 91, 94, 97, 101, 107
Nesomys audeberti 76
Ninox superciliaris 52, 91, 93, 96, 106
Nunenius arquata 39
phaeopus 39, 92
Nunida meleagris 92, 96
meleagris mitrata 34
Numididae 34
Nycticorax nycticorax 24, 25, 92, 96
Nymphaea 14, 125

Ocotea 9, 125
Oena capensis 41, 93, 96, 97, 99, 104
capensis aliena 42, 106
Oncostemon 11, 60, 125
Oplurus 33
Opuntia 77, 79, 125
Oriolus bernieri 82, 83, 101, 108
Otus rutilus 53, 93, 96, 99, 101, 102
rutilus rutilus 51–52, 106
Oxylabes madagascariensis 75–76, 81, 94, 97, 101, 102, 107, 114

Pachypodium 13, 125
Pachypitila vittata 23
Pandanus 8, 14, 27, 125
Pandion haliaetus 29
Pandionidae 29
Passeriformes 59
Pelecaniformes 23
Phaethon aethereus 23–24
Phaethonidae 23
Phalacrocoracidae 24
Phalacrocorax africanus 92, 96
africanus pictilis 23
Phasianidae 34
Phedina borbonica 55, 63, 93, 97
borbonica madagascariensis 62–63
Phelsuma 31, 81
Philepitta 61
castanea 59–60, 91, 93, 97, 101, 102, 107
schlegeli 21
Philippia 11, 82, 125
Phoenicopteridae 27
Phoenicopterurus minor 28
ruber [roseus] 27–28, 92
Phragmites 36, 90
communis 50, 125
Phyllanthus 9
seyrigii 42, 79, 125
Phyllastrephus apperti 107
cinereiceps 64, 65, 66, 93, 97, 102, 107
madagascariensis 74, 81, 93, 97, 101, 102, 114
madagascariensis inceleber 107
madagascariensis madagascariensis 64–65, 107
tenebrosus 101, 107
zosterops 64, 74, 76, 93, 97, 101, 102, 112, 114
zosterops andapae 107

zosterops fulvescens 107
zosterops maroantsetrae 107
zosterops zosterops 65–66, 107
Pithecellobium dulce 65, 75, 81, 82, 87, 125
Pittosporum 11, 125
Platypelis grandis 53
Ploceidae 88
Ploceus nelicourvi 88, 97, 101, 102, 108, 114
sakalava 30, 33, 67, 94, 97, 99, 104
sakalava minor 88–89, 94, 108
Pluvialis squatarola 37
Podicipedidae 23
Podicipediformes 23
Polyboroides 87
radiatus 30, 92, 96, 106
Porphyrio porphyrio [madagascariensis] 37, 92
Porphyryla allenii 37
Pothis scandens 9, 125
Procellariidae 23
Procellariiformes 22
Propithecus verreauxi 30, 32
Pseudobias wardi 21, 74, 94, 97, 107
Pseudocossyphus bensonii 107
imerinus 68
sharpei 93, 97, 102
sharpei sharpei 68, 107
Psittacidae 43
Psittaciformes 43
Pterocles personatus 41, 93, 96, 106
Pteroclididae 41
Pterodroma baraui 23
macroptera 23
mollis 23
Pteropus rufus 30
Puffinus atrodorsalis 23
pacificus 23
Pycnonotidae 64

Quivisanthe 44
papinae 30, 43, 45, 125

Rallidae 35
Rallus madagascariensis 35
Randia pseudozosterops 70, 91, 94, 95, 97, 107, 111
Rattus 53
rattus 51
Ravenala 27, 60
madagascariensis 9, 14, 17, 44, 125
Ravensara 11, 125
Rinoria greveana 14, 66, 75, 79, 125
Riparia paludicola 62, 93, 97
Rostratula benghalensis [benghalensis] 37, 92
Rostratulidae 37

Sarcolaena multiflora 44, 125
Sarcostemma 13, 71
decorsei 125
Sarkidiornis melanotos 28, 92, 96
Sarothrura insularis 36, 91, 92, 96, 106
Saxicola torquata 93, 97
torquata sibilla 67–68
Schetba rufa 85, 94, 97, 101, 114
rufa occidentalis 108
rufa rufa 80–81, 107

Scolopacidae 38
Scopidae 26

Scopus umbretta 92, 96
umbretta umbretta 26

Sloanea 10, 41, 61, 89, 90
rhodantha 9, 10, 11, 49, 125

Sorindeia madagascariensis 9, 125

Sphecius grandidieri 33

Stercorariidae 40

Stercorarius longicaudus 40

Sterna bengalensis 41, 93
bergii 40–41, 93
caspia 40, 93
dougallii 40, 93
hirundo 40
sandvicensis 40

Sternidae 40

Streptopelia picturata 32, 34, 93, 96, 99, 100, 101, 102, 104
picturata picturata 41–42, 106

Strigidae 51

Strigiformes 51

Strongylodon 11, 90, 125

Sturnidae 87

Sylviidae 68

Symponia 44, 50, 90, 125

Syzygium 9, 125

Tabernaemontana 14, 125

Tachybaptus pelzelni 23

Tamarindus 14, 30, 32, 43, 44, 46, 59, 64, 77, 86
indica 14, 45, 57, 75, 77, 79, 125

Tambourissa 9, 11, 125

Tarenna purinosum 13, 125

Terpsiphone 75
mutata 31, 45, 79, 94, 97, 99, 100, 101, 102, 104, 114
mutata mutata 74–75, 107

Thamnornis chloropetoides 70, 94, 97, 107

Threskiornithidae 26

Timaliidae 75

Tina isoneura 11, 125

Trachelopterus 31

Treron australis 43, 93, 96, 99, 100
australis australis 42, 106

Tringa nebularia 39, 92, 96

Turdidae 67

Turnicidae 35

Turnix nigricollis 35, 92, 96, 106

Tylas eduardi 31, 82, 94, 97, 102
eduardi eduardi 85–86, 108

Typhonodorum 14, 125

Tyto alba 93
alba affinis 51
soumagnei 106

Tytonidae 51

Uapaca 42, 43, 44, 125

Upupa epops 93, 97, 99, 104
epops marginatus 59, 107

Upupidae 59

Uroplatatus sikorae 53

Usnea 9, 125

Vaccinium 11, 125

Vanga curvirostris 30, 86, 87, 94, 97, 99, 100, 104
curvirostris cetera 81–82, 108
curvirostris curvirostris 81–82, 108

Vangidae 80

Vepris sclerophylla 13, 125

Weinmannia 9, 125

Xenopirostris polleni 82–83, 94, 97, 101, 108
xenopirostris 82, 94, 97, 108

Xerophyta 13, 41, 125

Zoonavena grandidieri 63, 96
grandidieri [grandidieri] 54, 93, 106

Zosteropidae 79

Zosterops maderaspatana 31, 80, 94, 97, 101, 102, 104, 105, 114
maderaspatana maderaspatana 79, 107